SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME 63 NOVEMBER, 1936 NUMBER 5

INTRINSIC FACTORS ALTERING THE ABSORPTION OF CATGUT

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THE purpose of this paper is to draw the attention of the surgical profession to some intrinsic factors in catgut, not previously stressed, which may alter its absorption. By intrinsic factors is meant structural defects and physical alterations in the material, the local and general effect of various chemicals incorporated in it and reactions which may be attributed to the specific protein of this suture material itself.

IMPROVEMENT OF METHOD OF DIGESTION DETERMINATION

In making determinations on the digestion time of catgut *in vitro* by a method previously described (6), it was noticed that occasionally a suture digested in very much less time than usual for that particular size and brand. This was at first thought to be due to imperfections in the mechanism and a careful revision of the method was made. A new apparatus was designed, shown in Figure 1, in which it is believed all the variables have been eliminated. A hook was fused in a glass centrifuge tube avoiding the use of a slip-knot on a glass rod, exactly 10 centimeters of catgut are measured on the tube, the beam is carefully balanced on a frictionless knife edge, and the clips are accurately counterbalanced by the switch trip. The switches themselves are mercury and therefore are frictionless. It was found by Stonehill that bacterial growth may be eliminated by the addition of 2 cubic centimeters of a 1:1000 solution of merthiolate in each 10 cubic centimeters of a 2 per cent trypsin digestion media. It has also been found useful to put 2 cubic centimeters of sterile albolene on top of the media to seal it from air contact.

DEFECTS IN STRUCTURE

With this improved method, another series of digestion determinations were made on the various sizes of catgut of three manufacturers, as shown in Table I. This shows the average digestion rate of plain and chromic, boilable and non-boilable, catgut. Several determinations were made in each instance, but it was found that occasionally a strand still digested in too short a time for the average of that variety. For instance, a strand manufactured by A digested in 13½ hours and the average digestion time for this type of gut was over 200 hours which was confirmed by numerous determinations. Another instance was the digestion of a strand in 5¼ hours when the average time was 14 hours. Feeling that all possible sources of error had been eliminated from the apparatus, a careful microscopical examination of the catgut itself was made with the hope that some explanation for these discrepancies might be made.

This led to some interesting observations. The most consistent was the presence of defects where the strands were bent to be put in the tubes as shown in Figure 2. Some

frayed ends may be seen which certainly would allow the digestion fluid to enter and digestion would be rapid at this point. Another rather startling discovery was the presence of large foreign bodies twisted in the gut (Figs. 3 and 4). This appears to be amorphous material of some kind, but the actual amount is too small to analyze. The most serious defects are obvious flaws. They do not occur very regularly, but the one shown in Figure 5 leaves only about half the normal width of the strand. It is believed that these occur when a ribbon is spliced.

Although not entirely consistent, the table also shows that the larger sizes do not necessarily last longer than the smaller sizes. The explanation of this may be that the digestive media penetrates between the ribbons and digests each separately. In chromic gut, the chromicizing may be on the outer layer only, and when this is penetrated digestion is rapid, while in the smaller sizes the chromicizing extends through the entire strand.

COMPARISON OF BOILABLE AND NON-BOILABLE CATGUT

It is thought that other alterations in the digestion time may be related to the amount of water in the suture material. In order to make catgut boilable, it must be completely dehydrated and supplied in a medium, usually xylol, containing no water as the boiling, of course, would hydrolyze the protein and destroy its properties. Consequently, boilable catgut is stiff, wiry, and inflexible. When this is put in the tissues it absorbs considerable fluid. To avoid this difficulty manufacturers have produced a non-boilable product which is prepared basically in the same manner as the boilable but put in a medium of 95 per cent alcohol and 5 per cent water. A smooth flexible gut is thus produced which resists digestion longer in most instances than the boilable gut, as is also shown in the table. This is attributed to the fact that more of the digestive media is absorbed by the dehydrated catgut than the one containing some water. The change in the size of the strand and its texture may be observed by immersing short sections of gut in dilute base (NaOH 1:100). The results of this are shown in Figure 6. The top row shows sections of non-boilable size 1 plain and chromic, size 1 of a foreign manufacturer, and size 1 boilable, plain and chromic. The second row shows sections of the same gut after 15 minutes exposure to the dilute base, the third after a half hour, and the fourth after an hour. The marked swelling, fraying, and change in texture of the boilable gut as compared with the non-boilable will be at once appreciated. It is believed that the lack of change of the foreign catgut is due to a chemical fixation to be discussed under that heading. The difference in the physical properties of boilable and non-boilable catgut may be observed also in sutures placed in living tissue. Figure 7 shows the appearance of non-boilable size 1 plain and chromic and boilable size 1 plain and chromic which have been allowed to remain a week in the musculature of a rabbit's back. It will be seen that the plain boilable is untied, and partially digested, the chromic slightly frayed, while there has been little or no effect on the non-boilable.

It is believed, therefore, that non-boilable catgut may be depended upon to remain in the tissues longer than the boilable, and its original property of flexibility tends to make the knots more secure and increases its efficiency in the other phases of operative technique. The only advantage of boilable catgut is that the outside of the tube may be boiled, but with the improvement in antiseptic agents, one may feel equally secure of the sterility of the outside of the glass tube, as it is one of the easiest materials to sterilize with our modern germicidal solutions.

EFFECTS OF CHEMICALS

When one considers the effect of chemicals on the absorption of catgut, the most complex problems present themselves. One of the difficulties is that the manufacturers often will not divulge the secrets of their processes, and it is only by testing for numerous chemicals (2), that one may learn what may be present in the gut.

As pointed out before, the most resistant catgut to digestion has been produced in foreign countries. Smith has stated that he prefers to harden the gut with formalin, and

TABLE I.—AVERAGE DIGESTION RATE OF CATGUT *IN VITRO*

Manufacturer	Size	Plain		*Chromic	
		Boilable	Non-boilable	Boilable	Non-boilable
		Hours	Hours	Hours	Hours
A	000	19½	23	207½	9½
B	000	14	17½	9¼	75
C	000	4½	5¾	31½	24
A	00	14	10	46¾	166½
B	00	8½	24¾	11¼	39¼
C	00	4¼	8½	25¼	25¼
A	0	6½	18¼	63	84¾
B	0	14½	10¼	51½	42¾
C	0	4½	7¾	33¾	12
A	1	22	17½	20	13½
B	1	11	10	33	70½
C	1	12	7½	27¾	12
A	2	14	15¼	33	45¾
B	2	5¼	11¼	23¼	9¼
C	2	8	8¼	12¼	11

*In each instance the chromic catgut was designated as medium-hard or 20 day variety.

it is believed that a great deal of foreign catgut has been preserved in this way during some stage of its preparation. Although it cannot be detected in all instances, it is probable that the formalin enters into chemical union with the protein when it fixes it and the surplus is removed during the subsequent processes. This foreign catgut was also buried in the muscle of rabbits' backs and found to be unchanged after 3 weeks. In Germany Haefen has made a similar but more extensive study of the absorption of iodized catgut buried in the muscle and subcutaneous tissue in the backs of animals. These were removed at various intervals and microscopic sections were made. The catgut was said to lie in canals, the walls of which showed aseptic necrosis. It was also observed that absorption took place very slowly and only after 4 months could one be sure that no more catgut remained in the tissues. He therefore points out how unnecessary it is to use metallic salts to prolong the absorption time further.

In these observations on the reaction about the suture, the aseptic necrosis of the wall of the suture canal may be attributed to the

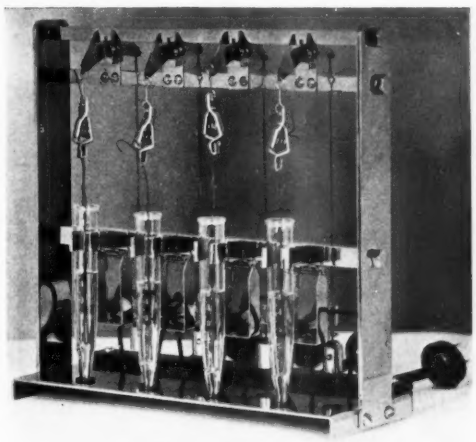

Fig. 1. Apparatus used in experiments.

liberation of the iodine. Schulze and Henning have found that the iodine content of iodized gut is from 3 to 6 per cent. Of this, 60 per cent is free iodine, 30 per cent is in the acid form, while only 10 per cent is combined with the albumin. Reil has studied the chemical reactions which take place about catgut. He says that the complicated proteins of the muscle tissue are broken down into polypeptides, dioxypiperazene, cystin, and glycocol. These are further broken down into ketones, carbondioxide, and amines, and the metals and halogens which may be present, being of positive ionic reactions, unite with the negatively charged tissue and cause a reaction.

It will be noted in Table I, that some of the boilable catgut (manufacturer A.—chromic 000) had a markedly delayed digestion time. This was labeled "germicidal catgut" and mercury was found to be present in it. Two quantitative analyses revealed an average of 5.05 milligrams in 1 gram of plain catgut equivalent to approximately two and two-thirds tubes of size No. 2. It is thought that the prolonged digestion time may be explained by an alteration of the enzyme action by the mercury.

The chemical, which is present in greatest concentration in the chromicized catgut, is of course the chromic acid. What action this has on tissues when it is liberated in small

Fig. 2. Fig. 3. Fig. 4. Fig. 5.

Fig. 2. Bent strands are noticeable.
Figs. 3 and 4. Foreign bodies in catgut.

Fig. 5. Flaw in catgut leaving only about half the normal width of the strand.

Fig. 6. Changes in strand and texture after immersion in dilute base.

amounts is interesting to contemplate. In larger amounts, it has been known for many years to be highly toxic (9), and offers a serious problem to workers who are exposed to it in industry (16). In addition to its local toxic and irritative effect (3), a considerably greater reaction may be expected if the individual is sensitive to the metal, a case of which was reported by Smith. As shown by Table III, a series of cases were tested for chrome sensitivity by intradermal tests of a 1:10,000 solution of chromic acid in saline. One patient gave a particularly marked reaction, a photograph of which may be seen in Figure 8.

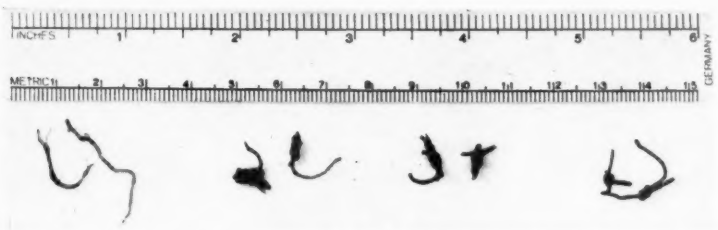

Fig. 7. Changes in boilable and non-boilable sutures after being placed in living tissue.

CATGUT ALLERGY

When one considers the question of sensitivity to catgut, the problems are even greater than with the toxic effect of chemicals. Babcock has raised this question and tells how it might be avoided by the use of steel alloy wire. The tests were made by Pratt and Small and consisted of burying short pieces of catgut in the sterilized skin of 120 patients. A reaction consisted of redness, flare, and wheal and was observed in every patient but varied in degree of intensity. In view of the fact that bacteria were present in the hair follicles and sweat glands and in view of the fact that absorbing suture material is an excellent culture media, and also because every patient exhibited a reaction, it is a question whether or not this test was a true demonstration of catgut allergy. Tripp has described a case of a patient, convalescing from a second operation, who suffered with severe asthma while it was assumed she was absorbing the catgut to which she was sensitized by her first operation. Unfortunately, her sensitivity to catgut was not demonstrated by a skin test.

Experimentally, Marchesani sensitized 5 series of guinea pigs with sheep serum, catgut extract, and catgut itself introduced intraperitoneally. After 14 to 40 days they were tested by intracardiac injections of catgut extract and sheep serum. In about one-third he was able to demonstrate sensitivity by general reactions. He also buried catgut in the tissue of normal and sensitized animals and found that in the latter there was hyperemia, edema, and a wide leucocytic wall, and even occasionally local necrosis.

Gratia and Gilson sensitized three series of guinea pigs, one to horse serum, one to sheep serum, and one to both sera. Catgut, itself, was introduced into the peritoneal cavity, and this caused marked local reaction, consisting of edema and hemorrhage and in some instances the exudate caused intestinal obstruction. The reaction was most marked in the animals sensitized with sheep serum and slight reactions were present in those sensitized with horse serum. It was believed that this manifestation of sensitivity may be responsible for some unsuspected causes of postoperative complications.

Moriconi was unable to produce evidence of allergy in two series of rabbits as determined by the demonstration of specific antibodies in

Fig. 8. Reaction to chromic acid intradermal test.

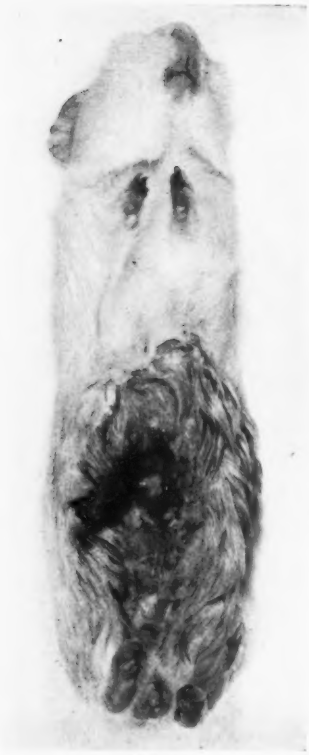

Fig. 9.

Fig. 10.

Fig. 9. Guinea pig No. 583. Disruption of wound after suture with plain cat;ut.

Fig. 10. Guinea pig No. 585. Wound disruption after suture with chromic catgut.

Fig. 11. Guinea pig No. 584. Normal healing after suture with plain catgut.

Fig. 11.

the blood, general or local reactions. He attributed this to a loss of specificity of the protein by the breaking down of the albumin into its component parts by the digestive elements of the body before going into the circulation. It is to be noted, however, that he was working with rabbits which are rather difficult to sensitize and it is probable that he was using catgut which was hardened by fixatives. As has been pointed out, catgut that has been put through this process absorbs very slowly.

With these experiments in mind, it was thought that it would be of considerable interest to determine whether or not there would be an alteration in wound healing in sensitized animals sutured with catgut and to see whether or not any of the cases of disruption which have occurred in the hospital could be explained on this basis.

Working with Dr. Beatrice Kesten, of the Department of Dermatology, a preliminary group of 19 guinea pigs were sensitized to plain and chromic catgut. This was done with intraperitoneal injections of a colloidal suspension, by burying catgut itself subcutaneously, and by closing abdominal laparotomies with catgut. In addition one was sensitized by intracardiac injection and another by repeated intradermal injections. Intradermal injections of approximately 0.1 cubic centimeter of extract were used to determine sensitivity. This extract was prepared by grinding the gut to a powder, sterilizing in an oven as described by Rappaport, and extracting by allowing 5 grams to be exposed to 100 cubic centimeters one hundredth normal sodium hydroxide in an agitator for 24 hours. This was diluted with saline (1:10 c.cm.) giving a final concentration of 0.13 milligram per 100 cubic

centimeters of the plain and 0.14 milligram of the chromic as determined by the micro-Kjeldahl method. Laparotomies were then performed on the animals and sewed with through-and-through bolt sutures of plain or chromic catgut.

The results of wound healing are shown in Table II. It will be seen that 6 of the 19 disrupted, 3 being sewed with plain and 3 with chromic: one of each being sensitized to the other type of gut. None of the six controls disrupted but one had slight redness and inflammation about the wound which subsided and the wound appeared normal in 2 days. The appearance of the disruption of a wound sutured with plain catgut is shown in Figure 9. A wound disruption sutured with chromic catgut is shown in Figure 10 while the appearance of a wound which healed normally, sutured with plain catgut is shown in Figure 11. This preliminary group of animals was relatively small for a scientific experiment and the experiment is being repeated on a larger group at the present time, but it has shown that disruptions may be produced in sensitized animals.

In an attempt to estimate the practical application of this principle, a thorough résumé was made of the 56 cases of wound disruption which occurred in the Presbyterian Hospital during the past 5 years. The various factors which may have been related to this serious complication were listed under the headings of sex, age, type of operation, method of suturing and suture material, drainage, general condition of the patient, presence of debilitating disease, the history of allergy, previous operations, complications during immediate postoperative period, time of removal of sutures, day of disruption, appearance of the wound at disruption, its repair, and the final result.

Although a wealth of information was gained by this review, only a few significant facts relate to our study. In every case in which the appearance of the suture material was described at the time of disruption, it was observed that the catgut was completely digested or only a few partially digested fragments remained. It was also interesting to note that of the entire group of 56 cases, 4 patients had histories of allergy and 32 had histories of previous operations. Twenty-six of these patients survived, and we were able

TABLE II.—REACTION OF GUINEA PIGS SENSITIZED TO PLAIN AND CHROMIC CATGUT

Pig No.	Route of sensitization	Skin reaction	Laparotomy	Wound heaing
551	Subcutaneous suture (Ch)	+	Plain	Normal
554	Subcutaneous suture (Ch)	+	Chromic	Normal
575	Intradermal injection (Pl)	+	Plain	Normal
578	Intracardiac injection (Pl)	+	Plain	Normal
579	Subcutaneous suture (Ch)	+	Chromic	Normal
580	Subcutaneous suture (Ch)	+	Chromic	Normal
562	Intraperitoneal injection (Ch)	−	Chromic	Normal
563	Intraperitoneal injection (Ch)	+	Chromic	Normal
555	Subcutaneous suture (Pl)	+	Plain	Abnormal
581	Intraperitoneal injection (Pl)	+	Plain	Abnormal
554	Subcutaneous suture (Ch)	+	Chromic	Abnormal
564	Intraperitoneal injection (Ch)	+	Chromic	Abnormal
556	Subcutaneous suture (Ch)	+	Chromic	2nd day disrupted
585*	Laparotomy (Ch)	−	Chromic	4th day disrupted
582	Subcutaneous suture (Pl)	+	Chromic	3rd day disrupted
583*	Subcutaneous suture (Pl)	Not tested	Plain	8th day disrupted
584	Laparotomy (Pl)	+	Plain	4th day disrupted
560	Intraperitoneal injection (Pl)	− +	Plain	3rd day disrupted
585	Control	−	Chromic	Normal
589	Control	−	Chromic	Normal
584*	Control	−	Plain	Normal
586	Control	−	Plain	Normal
587	Control	−	Plain	Normal
588	Control	+ −	Chromic	Abnormal

SUMMARY

Sensitized with:	Wound healing after laparotomy		
	Normal	Abnormal	Disrupted
Plain	3	2	3
Chromic	5	2	3
Control-plain laparotomy	3	0	0
Control-chromic laparotomy	2	1	0

*Photographs.

TABLE III.—INTRADERMAL TESTS TO SUTURE MATERIAL

	No. patients tested	No. patients giving positive reactions	Materials tested*								
			Catgut						Chromic acid		
			Plain			Chromic					
Patients without history of operation	140		+	±	−	+	±	−	+	±	−
Non-allergic	66	8	0	3	63	0	2	64	0	4	58
Allergic	74	20	9	4	61	2	3	69	5	4	60
Patients with previous history of operation	65										
Non-allergic	38	11	2	2	34	1	2	35	0	6	23
Allergic	27	10	2	3	22	0	2	25	2	1	22
Patients with disruption following operation	19										
Non-allergic	15	8	1	1	13	5	2	8	6	2	6
Allergic	4	4	2	0	2	1	2	1	2	0	2

*Control (saline)—no reactions.

to determine the sensitivity of 19 of these. Intradermal skin tests were made, the same type of extracts of plain and chromic catgut being used as in the animal experiments and in addition their sensitivity to chromic acid was determined. Of the 19 patients tested 4 reactions were observed to plain, 10 to chromic catgut, and 10 reacted to chromic acid as is shown in Table III. It is particularly interesting to note that all 4 of the allergic patients of this group showed sensitivity to one or more antigens. It was also thought that other allergic patients in the clinic might show a sensitivity to catgut or chromic acid. Of a total of 101 patients, 37 gave a response to one or the other as is shown in Table III. Finally, the incidence of sensitivity in a relatively normal group of patients, taken in the hospital wards and in the clinic, would be most instructive. Of this group of 104 only 22 were sensitive to one of the three antigens.

It is evident, therefore, that relatively normal patients are only occasionally sensitive to catgut or the chromic acid in it. The next highest proportion exists in the allergic group, and the highest in the cases which disrupted while all of the allergic patients who disrupted were sensitive. The impression must not be left, however, that all cases of disruption may be explained on the basis of sensitivity to catgut, but this certainly appears to be a factor, particularly in patients who have had a history of allergy.

CONCLUSION

1. The presence of flaws and "foreign bodies" in catgut emphasizes the necessity for careful examination of the product before it is used. Some method of supply other than in narrow glass tubes which kinks the gut at each bend should be devised.

2. By making catgut anhydrous so that it may be boiled, its properties of flexibility are lost and in most cases its absorption time is shortened.

3. During absorption of the protein in catgut, the metals and halogens it contains are liberated and may set up a local irritation in the tissue, thus interfering with wound healing. This is particularly true of chromium to which individuals may also be sensitive.

4. It is possible to sensitize guinea pigs to catgut and to produce disruptions of laparotomies sutured with this material. Nonallergic patients may be occasionally sensitive to it while allergic patients are quite often sensitive. The highest incidence of sensitivity was a group in which wound disruption had occurred and all allergic patients who had disrupted exhibited a sensitivity to one or more antigens. There may be a relationship between wound disruption and sensitivity to catgut or chromic acid in certain individuals, particularly if they have a history of allergy, previous operations, or exposure to chromic acid. It is recommended that if catgut is to be used, particularly in these instances, the

sensitivity of the individual should be determined by appropriate skin tests.

The author wishes to express his great appreciation to Mrs. Janet Cimiotti for her efficient voluntary technical assistance and to Miss Margaret Hamlin for assisting with the chemical analyses.

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OBSTRUCTIVE JAUNDICE

The Differential Diagnosis by Roentgen-Ray[1]

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THE differentiation of intrahepatic from extrahepatic bile block of the biliary passages is essentially that between medical and surgical jaundice, because most cases of extrahepatic block are dependent upon surgery for relief of the condition while those of intrahepatic block probably never are. Unfortunately, there are to date no accurate methods of segregating the medical from the surgical types in all cases, while the gravity of the surgical risk in jaundice makes a correct diagnosis doubly important. A moderate number of jaundiced patients with a history of common duct stone reveal at operation patent biliary ducts without gallbladder disease. They have then been subjected to an operation which, if the true condition had been known, either would not have been done or would have been delayed until after subsidence of jaundice, in which case the risk to the patient would have been greatly decreased.

In this study we are presenting a method which, we believe, will reduce the percentage error in differentiating operative from nonoperative cases. It is a modification of the Graham-Cole roentgen-ray technique and is dependent upon the fact that even though the common bile duct has been completely blocked, dye will still be excreted by the liver and concentrated in the gall bladder (9) where it will remain visible by roentgen-ray for several days. This method has been used in the study of animals in which jaundice had been produced by ligation of the common bile duct and upon patients with obstructive jaundice.

Although the objection has been made that administration of dye in the presence of jaundice is dangerous (McWhirter), and that the information gained is not worth the risk, Hawley, Walsh and Ivy, Rudisill, and Foley all agree that the dye is probably no more toxic in the presence of jaundice than in its absence. Foley states that this impression among clinicians has resulted from experiences with the precursors of dyes used at present.

The dye iodikon, when given intravenously, is excreted slowly over a period of many hours. From 5 to 10 per cent is excreted by the kidneys, approximately 20 per cent by the intestinal tract, and 65 to 70 per cent by the liver (2). The slow excretion is accounted for by the fact that dye is excreted into the upper intestine and resorbed in the lower (2). The dye, when given rectally, will often be sufficiently absorbed to visualize the gall bladder (2).

The excretion of the dye by the liver is facilitated by the simultaneous administration of sugar. Stewart and Illick have utilized this principle by giving sugar by mouth along with the oral administration of the dye to obtain a maximum liver excretion. They also decreased the kidney excretion and increased that of the liver by dividing the dose and giving the fractions at measured intervals, thus keeping the concentration of the dye in the blood at a rather low level.

The physiological principles cited have been applied in the following experiments. Jaundice was produced in 10 dogs by ligation and division of the common bile duct. One of these dogs had had a cholecystectomy 3 months previously. All were maintained on a balanced diet of meat, bread, and vegetables and, after becoming jaundiced, were given 25 milligrams of iodikon per kilogram body weight at 48 hour intervals for 3 doses. The dye was dissolved in 20 cubic centimeters of distilled water, then mixed with 25 cubic centimeters of 10 per cent glucose per kilogram body weight, and administered intravenously over a period of from 20 to 30 minutes. Thus over a period of 6 days the liver was exposed in the presence of glucose to approximately one and a half times the usual single dose given for ordinary gallbladder visualization. None of the animals

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Fig. 1. Roentgenogram showing appearance of dog's gall bladder 3 weeks following ligation and division of the common bile duct.

Fig. 2. The intrahepatic and extrahepatic bile ducts visualized by the dye 6 weeks after ligation and division of the common duct.

exhibited reactions attributable to the dye.

This routine was not carried out simultaneously on all the dogs but at varying intervals of from 3 weeks to 3 months after the onset of jaundice, the latter period being almost the limit of time over which a dog will ordinarily tolerate jaundice (1).

Roentgen-ray plates were made 20 and 48 hours after the administration of the last dose. Portions of the biliary system were visualized in every case. Some of these shadows were faint while others were clear cut, but the 48 hour pictures on the whole were more intense than those taken at 20 hours.

Three weeks after common duct ligation only the oval dilated gall bladder shows by roentgen-ray. At this time, the maximum gall-bladder distention has occurred although the liver changes are still young (Fig. 1).

Six weeks after common duct occlusion the liver still readily secretes dye and the dilated intrahepatic and extrahepatic ducts are visualized as well (Fig. 2).

It is possible to intensify still further the shadow of both gall bladder and ducts by giving a second course of dye injections 1 to 3 weeks after the first one and while no more data are obtained, the picture is far deeper and more readable (Fig. 3).

After cholecystectomy there is, of course, no gall-bladder shadow but the extrahepatic ducts may be clearly outlined by one course of dye, 3 weeks after duct ligation.

Careful examination of anteroposterior and lateral views confirm the fact that the dye is in the bile ducts and not the intestine. The spotty distribution is due to the tendency of the dye to pool and sediment on standing (Fig. 4).

From the results of these experiments and those cited from the literature it is apparent that in the presence of common duct block, even of considerable duration, dye can be made to permeate the liver and that it will remain demonstrable by roentgen-ray for 48 hours or longer. The fact that the dye is

Fig. 3. Three months after ligation and division of the common bile duct, the dilated gall bladder and ducts of the dog are clearly outlined by two courses of dye.

Fig. 4. Bile ducts visualized in a dog 3 months after cholecystectomy and 3 weeks after duct ligation.

excreted in a large proportion of cases of intrahepatic block is generally known. However, in such cases, whatever dye is visible 20 hours will have passed from the biliary tract to the intestine before 48 hours has elapsed, while in the presence of a non-functioning gall bladder the dilated bile ducts should become visible.

CLINICAL APPLICATION

Accordingly, dye was given to 17 patients suffering from well developed jaundice, 12 of whom were completely blocked. The first 3 patients were given 250 milligrams of iodikon in 1000 cubic centimeters of a 10 per cent glucose solution. This procedure was repeated three times at 48 hour intervals, according to the schedule here outlined. The next 3 patients were given 500 milligrams at a dose and the rest 750 milligrams each dose. For the first 3 patients the dye was mixed with 20 cubic centimeters of distilled water, filtered, and emptied directly into the flask of glucose solution. No reactions were noticed other than the occasional chills which may follow administration of glucose alone. At the bottom of the emptied flasks, which had been standing over night, there was sometimes a small amount of precipitate, but the precipitate from the mixture of glucose and dye forms very slowly and if the solution is administered immediately after mixing, no concern need be felt over reactions from this residue. The last 11 patients were given three 750 milligram doses of dye at 24 hour intervals instead of 48. Pictures in every case were taken 20 hours and again 48 hours after administration of the last dose of dye. A fat meal was given after the 24 pictures were taken. In those cases in which the gall bladder or bile ducts were unable to empty because of block at the ampulla, pictures were taken at intervals up to a week after the last dose of dye had been given.

By operation, autopsy, or cholecystography after the jaundice had cleared, 12 of the 17 patients were shown to have intrahepatic block. Of these 12, 3 showed clear cut gall-

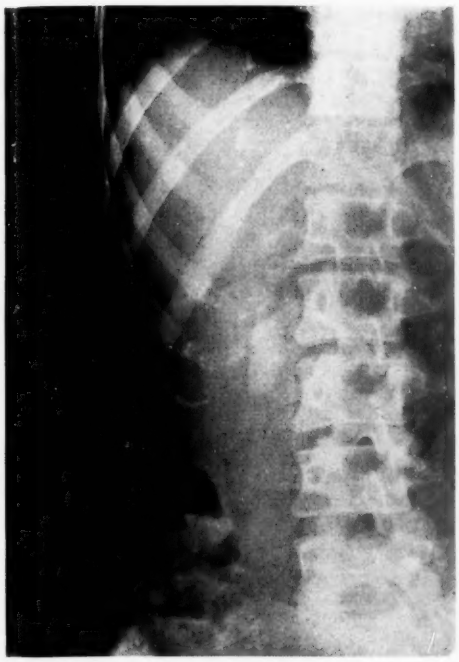

Fig. 5. This shadow of a smooth, flaccid gall bladder was seen 20 hours after administration of dye. The gall bladder emptied and there was no shadow at 48 hours. Although the history and pain were typical of stone, catarrhal jaundice was found upon operation.

bladder shadows at 20 hours, which in every respect corresponded to that of a normal gall bladder. None showed a shadow after 48 hours (Fig. 5).

Two of these patients were operated upon in spite of normal cholecystography because of the typical history and physical findings of common duct stone and because they were observed in the hospital during attacks of colic which were identical with that produced by a stone. At operation the gall bladder and bile ducts in each case were normal. The patients subsequently recovered and were discharged with a diagnosis of catarrhal jaundice. Four of the 12 proved to have carcinoma of the liver; 2 at operation and 2 at autopsy. The primary site of the tumor was in the gall bladder in 2 cases, and in the hepatic ducts and ovaries in 1 each. In all 4, the block was above the junction of the cystic and common ducts and no dye could

Fig. 6. (RC) A clear gall-bladder outline is shown 48 hours after dye administration. Shadows simulating stones are seen due to pooling of the dye on standing. Jaundice of 3 months' duration was due to carcinoma of the head of the pancreas.

be concentrated in these gall bladders. Roentgenograms consistently showed no gall-bladder or duct shadows and in the two operative cases surgical relief was impossible. This, we felt, had already been indicated by negative cholecystography. Two patients revealing no shadow recovered under medical care. The clinical diagnosis in each case was catarrhal jaundice, but no subsequent cholecystograms could be obtained to corroborate this diagnosis. We have found, however, that at certain stages in acute catarrhal jaundice, no dye is excreted by the liver, and we place these two cases in that class.

One patient (RC) had been jaundiced 3 months. During the last month she was confined to the hospital with a complete obstruction of the common duct. The diagnosis was uncertain, the opinions of the attending staff being about evenly divided between intrahepatic and extrahepatic block as the cause of jaundice. The gall bladder could not be felt because, as was later found, it pointed posteriorly and downward. Plain plates, negative. Those taken 48 hours after a course of 750 milligram doses of dye revealed a dilated gall bladder apparently filled with small stones.

Fig. 7. The same patient (RC) 5 days after the last dose of dye. The gall bladder is unemptied, with the dye settled to the tip of the fundus.

The gall bladder still visualized well at the end of 3 days and after 5 days the dye was shown settled to the bottom of the gall-bladder cavity.

This patient refused an operation and remained completely blocked until her death 6 months later. A small carcinoma of the head of the pancreas completely blocking the duct was found at autopsy. The ducts and gall bladder were greatly distended but contained no stones. The appearance of stones in Figure 6 was caused by the uneven distribution of the dye on remaining in the gall bladder over a long period of time.

The sixteenth case was a 77 year old man (J.L.) who had been completely blocked for 9 months. Dye was administered by the method described without reaction and pictures showed faint shadows of stones outlined by dye (Fig. 8).

These stones did not show on a plain plate. Because of these roentgen-ray studies and his good physical condition, a laparotomy was

Fig. 8. (J.L.) Faint shadows of stones in the greatly distended common duct outlined by dye after 9 months of jaundice.

done and the common duct was found to be tremendously dilated and filled with stones. The gall bladder was a mass of fibrous tissue.

The last patient had a painless jaundice of 6 weeks' duration. A large, smooth mass could be felt at the liver edge which was evidently a distended gall bladder. Roentgen-ray plates after dye injection showed a large, smooth edged, pale shadow corresponding to location of the mass. The identity of the shadow with the gall bladder could not be confirmed as the patient refused operation and autopsy could not be obtained after death some time later. We were certain, however, that the shadow revealed was that of the distended gall bladder.

SUMMARY

Iodikon, given according to the method described to a group of 17 jaundiced patients after preliminary administration to 10 jaundiced dogs is not followed by bad reactions, either immediate or delayed. The extrahepatic biliary system can be visualized in every dog, even though as long a time as 3

months may have elapsed after production of jaundice by ligation and division of the common bile ducts. In the absence of the gall bladder in one dog the bile ducts were well visualized. Likewise the biliary system can be demonstrated in patients suffering from common duct obstruction. The shadows obtained remained visible in both animals and patients for a period of 48 hours or longer. This is greatly in excess of the normal emptying time of the unobstructed extrahepatic biliary system, the extreme limit of which is 36 hours (2).

The observations here reported show that the liver will excrete the dye in the presence of complete common duct obstruction of long duration and that this dye which has reached the extrahepatic biliary system is held there by the duct obstruction. Furthermore, the dye is not resorbed from the gall bladder but remains visible by roentgen-ray for 48 hours or longer and clearly demonstrates common duct obstruction.

The dye held in the gall bladder over a long period is often unevenly distributed or gathered in pools, giving a false appearance of stones. It also may settle to the tip of the fundus, giving a dense, semilunar shadow if the patient has remained quietly in bed.

On the other hand, the dye given to patients with jaundice due to intrahepatic obstruction fails to visualize the biliary system in a single case after 48 hours. Although normal gall-bladder shadows may be seen at 20 hours, the gall bladder empties at 48 hours and no shadow is cast. Two of 3 such patients with clinical pictures of common duct stone proved at operation to have catarrhal jaundice. The gall bladder and bile ducts were normal.

The diagnosis without the roentgen-ray is uncertain in many cases of jaundice in spite of the fact that full hospital and laboratory facilities are at hand, but may be made by the method described in some instances. With our present meager experience with this method, we feel that it offers an effective means of differentiating intrahepatic from extrahepatic biliary obstruction in most cases, and would confidently withhold operation where such tests give positive evidence. The routine administration of the dye by this method takes several days but does not delay treatment inasmuch as several days' hospitalization and pre-operative glucose administration is required.

CONCLUSIONS

1. Dye given intravenously in divided doses with glucose is excreted by the liver in the presence of complete block of the common bile duct, of either short or long duration.

2. Dye so excreted is not resorbed from the gall bladder but remains and is radio-opaque at least several days to a week.

3. If the extrahepatic biliary system is visible by roentgen-ray more than 48 hours, the obstruction is in the common duct.

4. The presence of a functioning gall bladder is not necessary for the roentgen-ray demonstration of common duct block by this method, since the bile ducts outside the liver will visualize even if the gall bladder is absent.

5. The method offers a reliable scheme of differentiating extrahepatic from intrahepatic biliary block in jaundice.

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DURATION OF VOLUNTARY APNEA[1] IN THYROTOXICOSIS

An Index of Stability and a Criterion of Operative Risk[2]

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A NOTE as to our interest in the development of the breathholding test in thyrotoxicosis may not be amiss since there have been no contributions by other authors to the subject, to the best of my knowledge. Some 10 years ago my father observed that intensely hyperthyroid patients, not yet properly stabilized for operation, could not be anesthetized fully with nitrous oxide oxygen without accompanying cyanosis, and that postoperative deaths in thyrotoxic crisis occurred almost entirely in this group. These patients were thereafter recognized following induction of anesthesia but before operation was started and were returned to their beds without operation. Their obvious intolerance of the slightest withdrawal of oxygen led him next to the observation that they could not hold their breath to anything like the normal duration. Postponement of operation in such a patient until a radical improvement in the ability to hold the breath occurred was followed by induction of anesthesia without clinical cyanosis, diminishing of the incidence of alarming increase of pulse rate and blood pressure during operation and a smooth postoperative course. I first became familiar with these facts in 1928 and have attempted to systematize an investigation into the ability of the thyrotoxic patient to hold his breath during the course of the disease, to correlate changes in this ability with the other tests by which we estimate improvement in his condition, and to determine the value of this physical sign as a criterion of operability.

It seemed desirable at an early date to test the ability to hold the breath in two phases —after a maximal inspiration and after a maximal expiration, and the technique of this test to which we have adhered was published in 1930 (1) and has been referred to since (2, 3). The preliminary report embraced a review of the literature on breathholding tests in health and disease, their correlation with vital capacity, an outline of the mechanism of the regulation of respiration so far as the experimental literature takes us, and a detailed study of observations at intervals on 35 patients; this established certain facts which have been largely confirmed by our experiences in the 4 years subsequent to that publication. The physiology of respiration is still obscure enough that we can go no further in explaining the reaching of a "breaking point" during voluntary apnea than Gesell's conclusion that it is determined by the acidity of the respiratory center itself and that this coincides with the hydrogen-ion concentration of the blood only under special conditions. There has not yet been published well substantiated evidence of changes in any of the factors influencing the efficiency of the arterial blood as a carrier of hydrogen ions in thyrotoxicosis to account for variation in the acidity of the respiratory center from this source, nor are there clearly established changes in tissue metabolism to which the complex buffer system of the center itself can be shown to be inadequate in maintaining normal hydrogen-ion concentration. Consequently we are unable to throw any further light on the physiological basis for the breathholding test at this time than we could in our preliminary report. (That there is no constant relationship between duration of voluntary apnea and vital capacity has been amply shown—4).

The present paper will confirm the previous finding that in thyrotoxicosis there occur (1) a decrease in the duration of the apneic interval in both phases and (2) a characteristic alteration of the *relationship* between their numerical values and that a return toward normal values occurs as the patient improves and achieves sufficient stability to withstand operation. Further evidence of the correlation of the test with other clinical and laboratory data such as pulse rate, blood pressure, and basal metabolism will be presented in

[1] For convenience in case reports and chart "Duration of voluntary apnea" has been abbreviated to "D. V. A."

[2] Read before the Western Surgical Association, December 7, 1935, at Rochester, Minnesota.

subsequent papers. Determinations on patients with congestive heart failure (decompensation), anemia, nephritis or ketosis associated with diabetes mellitus are not included in the figures to be given.

TECHNIQUE OF TEST AND NORMAL VALUES

The test is performed under basal conditions (for purposes of investigation). A simple explanation of the plan of testing, of its safety, and of its value to the patient is always made and is necessary to insure against false starts or failure to reach a true breaking point with consequent frequent repetition of the test. It is not true that the patient improves with practice but it is importantly true that the examiner does; familiarity with the procedure enables one to recognize less than maximal effort; patience in securing the attention and co-operation of the patient before the test is started and intelligent coaxing or urging during the test minimize the occurrence of false values. The duration of the apneic interval after expiration is usually made first. A maximal inspiration is taken, followed immediately by a maximal expiration and the nares are lightly compressed by the examiner's fingers; the duration is counted with the watch from the *start* of the expiration until the breaking point is reached, since some persons will exhale in 2 seconds whereas others, in spite of example and instruction, will exhale over a period of 5 or even 10 seconds. After a rest period of at least 5 minutes the inspiratory phase is determined; a maximal inspiration is taken, followed at once by a maximal expiration and the ensuing maximal inspiration is held, with compression of the nares as before. The duration is measured from the start of the final inspiration since some persons fill their lungs more rapidly than others.

The duration of the inspiratory phase is then placed over the duration of the expiratory phase and the fraction thus obtained expresses the duration of voluntary apnea which we abbreviate for convenience to "D.V.A." The *arithmetical value* of the fraction (numerator divided by denominator) we call the index of stability. For example, an inspiratory phase of 40 seconds and an expiratory phase of 20 seconds is recorded as D.V.A. 40/20, index 2.

Since preliminary inspirations increase the apneic interval, our figures on non-thyrotoxic patients are not exactly comparable with determinations made by other techniques. Such preliminary inspirations, however, have seemed essential to insure complete emptying or filling of the chest, as the case may be, in the phase to be measured; this simply takes into account the inability of the average thyrotoxic patient to concentrate his attention readily on any task. Since the ability of healthy persons to hold the breath under basal conditions varies so widely with physical training (vocational or avocational), it is impossible to set definite limits of normal. Averages, however, of large series of normal individuals, are reported by various authors: Wittich and Polczak give an average of 56 seconds and 36 seconds for inspiratory and expiratory phases, respectively, in a group of 275 men in a gymnasium class and 47 seconds and 31 seconds for a group of 63 university women (the expiratory phases are determined here after normal, not forced, expiration); Jackson and Lees, using the same technique in 100 university students, report averages of 72 and 33 seconds with ranges of 34 to 176 and 14 to 96 seconds for inspiration and expiration, respectively; after maximum expiration the average was 24 seconds with a range of 11 to 75. It is obvious, therefore, that with such a wide range of results on persons in health, one can only estimate as best he can the *expected* normal of any person suffering from a disease which decreases his ability to hold his breath. It is my own impression, as a result of making perhaps a thousand tests on patients with toxic and non-toxic goiters, that men in general and young women who have had regular exercise, particularly in organized athletics, will reach and exceed 45 seconds after expiration (under basal conditions in health) and that the duration of apnea after inspiration will be about twice as great. On the other hand, persons, particularly women, who have led sedentary lives and have accumulated the usual amount of fat in early middle life will not often exceed 30 seconds in the expiratory phase; the in-

spiratory phase is, again, about twice as long with the technique described. From these two main groups come the thyrotoxic patients as we see them. As they return to health the breathholding ability returns to the expected duration which can be predicted with fair accuracy. Nevertheless, the wide range of normal values and the impossibility of prediction with absolute accuracy of the duration of voluntary apnea in health make a series of observations on any patient of considerably more importance as an indication of improvement than does a single estimation, considered as an absolute expression of his clinical condition at that time; knowledge of previous estimation, whether the patient was worse or better, in general, distinctly adds to the certainty with which the test can be applied when action is contemplated.

The index of stability is of equal importance, perhaps. As has been said, determinations on normal individuals with the technique described show the inspiratory phase to be about twice as long as the expiratory phase. Actually, the index varies within very narrow limits in health, from person to person, and the variation in the findings between 1.8 and 2.0 is probably an expression of the limits of error inherent in the method of starting and finishing the timing. It is characteristic of acute, untreated thyrotoxicosis that a deviation away from the normal index is always found. The index approaches a value of 1.0 in the majority of the patients we see; they come from the group of individuals who are best characterized as being housewives of sedentary habits and though both phases of voluntary apnea decrease as the patients become thyrotoxic, the actual duration in both phases may become practically the same. A minority of patients present themselves with values above 2 for their indices; these persons, in health, belong to the group who are physically active and run quite true to form in having had special training of one sort or another. In them the reduction of the duration in both phases during thyrotoxicosis is proportionally greater in the expiratory phase than in the inspiratory, and the index on first examination may be 3 or even 3.5. But in both groups improvement in clinical appearance is accompanied by increase in both phases of breathholding ability and by an improvement in ratio *toward* the normal.

PRESENT MATERIAL

In the material presented herewith, only the findings in those patients who belong to the majority group are included in order to show the typical changes in duration of voluntary apnea and index at varying levels of thyrotoxicosis. The inclusion of figures for the minority group and the averaging of both together only obscure the characteristic behavior of each. The data on the minority group will be presented in a separate paper.

The 178 observations on 111 patients have been recorded in respect to pulse, blood pressure, basal metabolism, duration of voluntary apnea, circulatory compensation, and weight as well as other clinical characteristics, with sufficient completeness that they are useful in critical analysis. These observations (except determinations of basal metabolism) have been made personally by the author and were made on patients in only one hospital. The patients fall naturally into four groups: Group 1 (12 cases) consists of non-thyrotoxic patients. Group 2 (59 cases) consists of those hospitalized only once and having subtotal thyroidectomy (or single lobectomy, occasionally, in the case of unilateral growths). Group 3 (11 cases) consists of patients who were hospitalized only once but who had separate lobectomies (2 stage operation) performed at that hospitalization. Group 4 (29 cases) includes all patients hospitalized more than once; it consists of (a) patients who (in 1930 and 1931) had upper pole ligations and returned for thyroidectomy in 1 or 2 stages, (b) the patients who had separate lobectomies at different hospital stays, and (c) a few patients who were hospitalized when on the verge of crisis, discharged for home treatment for periods varying from 1 month to 4 months, and brought back for operation in 1 or 2 stages (these individuals would have had pole ligations performed at first hospitalization prior to 1932; we no longer regard pole ligation as being of therapeutic benefit —3). In passing, it may be said that the minority

group excluded from this presentation consisted of 22 thyrotoxic patients, 12 in Group 2 and 10 in Group 4. These figures must not be taken as indicative of the percentage of cases in our practice in which more than one hospitalization is required, or in which 2 stage operations are performed; it is natural that records kept with detailed completeness sufficient for investigative purposes are most apt to be those in which the patient is so sick that exact thinking is required. Only a minority of our mildly thyrotoxic and nontoxic goiter patients during the period of this study (June, 1930, to June, 1933) are included.

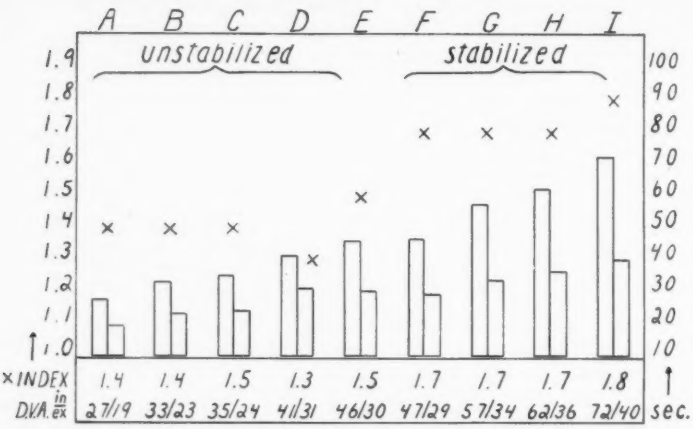
The following illustrations record the progress of individuals in the 3 groups of thyrotoxic patients.

Group 2, Case 53, Miss P. N., aged 51 years, admitted March 5, 1931; diffuse hyperplastic goiter.
March 5. Pulse, 105; blood pressure, 128/55–40; D.V.A., 33/21; index, 1.6; basal metabolic rate, +34 on March 6.
March 8. Pulse 100; blood pressure, 110/70; D.V.A., 40/25; index, 1.6.
March 16. Pulse, 84; blood pressure, 120/80; D.V.A., 70/40; index, 1.8; basal metabolic rate, +14.
March 17. Subtotal thyroidectomy, slight reaction.
March 26. Pulse, 90; blood pressure, 110/80; D.V.A., 116/62; index, 1.9; basal metabolic rate, −3; discharged.
Group 3, Case 11. Mr. R. H., aged 30 years, admitted June 26, 1933, with diffuse hyperplastic goiter.
June 27. Apex, 120 (fibrillating); D.V.A. 45/28; index, 1.6; basal metabolic rate, +91.
July 5. Apex, 98 (fibrillating); D.V.A., 45/38; index, 1.2; basal metabolic rate, +50.
July 10. Apex, 86 (fibrillating); D.V.A., 63/35; index, 1.8; basal metabolic rate, +57.
July 12. Right lobectomy; moderate reaction.
July 19. Apex, 84 (fibrillating); D.V.A., 72/43; index, 1.7; basal metabolic rate, +32; left lobectomy.
July 27. Pulse 84 (regular); blood pressure, 125/75; D.V.A., 95/48; index, 2.0; basal metabolic rate, +4; discharged.
Group 4, Case 28. Mrs. H. L., aged 52 years, admitted June 2, 1931; diffuse hyperplastic goiter.
June 5. Pulse, 120; blood pressure, 210/80–50; D.V.A., 15/12; index, 1.3; basal metabolic rate, +91; weight 145.
June 9. Pulse, 96; blood pressure, 170/65–30; D.V.A., 30/20; index 1.5.
June 11 and June 17. Ligations.
June 27. Pulse, 90; blood pressure, 174/70–0; D.V.A., 23/20; index, 1.1; basal metabolic rate, +77; weight, 131.
June 29. Discharged.
October 13. Readmitted.
October 15. Pulse, 108; blood pressure, 185/80; D.V.A., 25/17; index ,1.5; basal metabolic rate, +74; weight, 158.
October 27. Pulse, 96; blood pressure, 190/90; D.V.A., 40/28; index, 1.4; basal metabolic rate, +26.
October 29. Right lobectomy, moderate reaction.
November 9. Pulse, 98; blood pressure, 198/78–0; D.V.A., 36/22; index, 1.6; basal metabolic rate, +20.
November 12. Pulse, 90; blood pressure, 150/65; D.V.A., 40/27; index, 1.4.
November 14. Left lobectomy, moderate reaction.
November 26. Discharged.

The graphic recording of a group of such records presents something of a problem in itself and I wish herewith to express my gratitude to Evarts Graham for his suggestions in the preparation of this material for publication. The accompanying chart shows graphically the changes in the duration of voluntary apnea and indices throughout the range of thyrotoxicosis in these patients.

DISCUSSION OF CHART

As indicated, the data in columns A to E, inclusive, are those of patients who can be said to be as yet unstabilized whereas those in columns F to I are stabilized, the last, of course, being non-thyrotoxic. In reviewing individual cases it is seen that the dividing line is not sharp, but the average index of non-stabilized patients is 1.5 or less and the index of the stabilized patient ranges between 1.7 and 2.0. Moreover, the margin between columns E and F is negligible so far as duration in either phase is concerned. It is here that series observations are of most value, and it is partly on the basis of improvement over previous tests and partly on other clinical criteria that the patients in column F were considered to be stabilized and those in column E were thought not to be. Column F is a composite group made up of immediately pre-operative data on all patients having first lobectomy in a planned 2 stage operation. This includes three subgroups: (1) 12 patients discharged from the hospital after the first stage for an average interval of 95 days between stages. The average duration of their ability to hold their breath is



Summary of typical changes in duration of voluntary apnea (D.V.A.). A, Admission data on patients to be ligated (6). B, Pre-ligation data (8). C, Admission data on patients hospitalized more than once for 2 stage operation (5). D, Admission data on non-stabilized patients becoming suitable for subtotal thyroidectomy (26). E, Admission data on patients having 2 stage operation at one hospitalization (8). F, Prelobectomy data—first stage thyroidectomy—(27). G, Prelobectomy data—second stage thyroidectomy—(23). H, Pre-operative data on all thyrotoxic patients having subtotal thyroidectomy (63). I, Pre-operative data on all non-thyrotoxic patients (12).

45/27, index 1.6; they are characterized by being over 50 years of age and having thyrotoxicosis of long duration with extreme loss of weight. Such individuals do not often become reasonable risks for 1 stage operation in our experience. They show moderate early improvement on first hospitalization (see admission data in column C) but do not spontaneously improve further. (2) Six patients who had previously been hospitalized (4 ligated) returned for 2 stage operation at the second hospitalization; they had been extremely thyrotoxic on first admission, 2 having been delirious and 2 others having been decompensated. (Most of them appear in column A.) In the immediately prelobectomy phase there was still so marked a tachycardia in these patients that we were unwilling to risk subtotal operation, and the fact that the postoperative reaction was more than mild in 4 cases convinces us that we were not overcautious. Their average duration of voluntary apnea was 49/34, index 1.4, immediately before first lobectomy. (3) Observations were recorded before first lobectomy on 9 patients who were hospitalized only once and had 2 stage operation performed; they were marked clinically by being under 50, with one exception, but with considerable weight loss and an average basal metabolic rate of +60 on admission. Of these patients 5 were men, which raises the average duration of voluntary apnea on admission somewhat, and 3 showed little or no improvement in duration of voluntary apnea over admission figures (see column E). Postoperative reaction following the first lobectomy was characterized as "moderate" in 5 and 2 other patients had very severe reactions. The average duration of voluntary apnea was 49/27, index 1.8, before first lobectomy.

The same groups of patients appear in column G and it is worth emphasizing that a patient sick enough to require 2 stage operation should be *measurably* in as good condition for the second lobectomy as for the first. If division of the operation into stages is truly warranted the first stage will use up all the energy the patient can spare and he will not regain his pre-operative status in a few days. The average interval between stages was 11 days in those cases here mentioned who were hospitalized more than once and in whom no direct attack on the gland

was made at first hospitalization. In the patients hospitalized only once, the average interval between stages was 12 days. We have thus avoided in recent years the deaths after second stage operation that formerly occurred from the assumption that because first lobectomy had been well tolerated, second lobectomy could always be done within a week or so. The re-estimation of the duration of voluntary apnea shows us that stability is not often regained so soon.

Column H requires little elucidation. There is little difference in the averages of the 3 subgroups which compose it. (1) Single observations immediately before subtotal thyroidectomy were made on 34 patients hospitalized only once; the duration of voluntary apnea 65/36, index 1.8. (2) Observations immediately before operation were also made on 20 patients on whom observations on admission had been made (see column D), pre-operative duration of voluntary apnea 56/35, index 1.6; average interval 8 days. (3) On 9 patients returning to the hospital for subtotal thyroidectomy at an average interval of 147 days following ligation of upper poles, average duration of voluntary apnea 61/37; index, 1.7. There was little difference, therefore, between the patients judged to be suitable for subtotal thyroidectomy whether the length of time necessary to achieve stability was 10 days or several months. But, as has been mentioned in the discussion of column F, a group of 6 patients previously ligated and judged to be suitable only for 2 stage operation on return showed a duration of voluntary apnea of 49/34, index 1.4, before the first lobectomy. Between these two groups the difference in duration of voluntary apnea is therefore readily measurable.

Column I requires no discussion beyond the pointing out that here the largest average values for duration of voluntary apnea are found with, of course, a characteristic index of stability. It is the one extreme of the picture of which the other is column A which presents admission observations on patients too sick to permit of any direct attack on the gland (if one excepts ligation) within a period of 2 to 3 months from the time they first present themselves for treatment.

CLINICAL APPLICATIONS

Like many other methods of investigation of the deranged physiology of thyrotoxicosis the estimation of duration of voluntary apnea is not necessary to the safe handling of only mildly hyperthyroid patients. But we find it invaluable in making the decision between subtotal thyroidectomy and 2 stage operation (separate lobectomies with an interval of weeks or months between them) for the severely thyrotoxic individual. One faces this choice in two situations: (1) with the patient who is making a slow but steady recovery after having recently been in desperate straits due to cardiac decompensation, diarrhea, loss of over one-third of average weight, etc.; (2) with the patient who remains quite refractory to treatment and is moderately thyrotoxic over a prolonged period. In such cases, all other criteria (3) being satisfactory, the findings of voluntary apnea of the stabilized type, however (ample duration with index of 1.7 to 2.0) encourages us to risk 1 stage operation; in the presence of a voluntary apnea of the unstabilized type, however (index lower than 1.5, regardless of duration) we will do only a 2 stage operation and the postoperative reaction of these patients rarely leads us to think that we have been too prudent. Finally, the objective value of voluntary apnea duration in re-establishing operability of the patient between first and second stages has previously been mentioned.

Even after becoming thoroughly familiar with the use of the test, one need not expect to find a close, constant parallel between changes in the duration of voluntary apnea, pulse rate, basal metabolism, etc., in the progress of a case. There is a general correlation in these and other criteria as the patient grows better or worse, but there is so obviously a selective mechanism at work in thyrotoxicosis, in that the chief expression of the disease varies among different organ systems from case to case, that the patient is rare who improves in all respects at the same rate. Our various clinical criteria in thyrotoxicosis, to which the breathholding ability test is an addition, probably measure quite dissimilar facets of this many sided disease.

CONCLUSIONS

1. Inability to hold the breath to normal duration is described as a physical sign in thyrotoxicosis.

2. In both inspiratory and expiratory phases the duration of voluntary apnea (D.V.A.) is diminished and there is a characteristic alteration of the relationship between them (index of stability).

3. In typical untreated thyrotoxicosis the index of stability tends to approach a value of 1.0. Clinical improvement is accompanied by a reversion toward normal range, 1.8 to 2.0.

4. The ultimate physiological basis for the test is uncertain.

5. Typical changes in regard to duration of voluntary apnea (D.V.A.) and index of stability in 111 patients with varying grades of thyrotoxicosis are shown graphically in a chart.

6. The clinical application of the breath-holding test is discussed.

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ACUTE PELVIC APPENDICITIS[1]

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THE purpose of this paper is to bring forcibly to your minds a certain form of appendicitis with atypical symptoms; a form of appendicitis which is often overlooked, at least in its early stages.

We have found that when the appendix is pelvically placed, either over the brim or deep within the pelvis, the symptoms arising when it becomes inflamed are most unusual. On the other hand, it is our belief that as a rule an early diagnosis can be made if we consider this type of appendicitis an entity and recognize the peculiar symptoms which it produces.

In looking over the literature, every once in a while one comes across the term "pelvic appendicitis"; but, so far as I know, no one has mobilized all the symptoms—and I might also say the lack of symptoms—which cause the surgeon to suspect the diagnosis. In an article by A. R. Short[2] on "Abdominal Pain in Children," he says, in speaking of appendicitis, "Difficulty in the diagnosis is caused by the pelvic appendix, both in children and adults. In the great majority of unrecognized and fatal cases of appendicitis, the appendix is of this type."

Such observations as these have been made many times, but no one has brought together in a concrete way the various symptoms which may make it possible to reach an early diagnosis with a certain amount of assurance. On our surgical services we have for many years used this term; and have had definite criteria on which to base a diagnosis. During the past few years 90 per cent of the cases of ruptured appendix referred to me, either for operation or for consultation, have been of this group.

The constant symptom is pain, usually very severe, which at the onset does not differ particularly from that of any appendiceal attack. In referring back to the histories of these cases, I find that the pain may start in the epigastrium or around the umbilicus, but soon settles in the lower abdomen. In the great majority of cases, the history is that of a well individual waking up suddenly at night with a severe abdominal pain that prevents sleep. When localization of the pain takes place, it is more frequently on the left than on the right side. In older individuals, diverticulitis must therefore be thought of, but in young people this seldom enters into the diagnosis. While at times the pain may be on both the left and the right sides, or on the right side alone, in our series of cases it is more commonly complained of on the left; and this to us is the first indication of a possible pelvic appendicitis.

Vomiting may or may not ensue. Many times it is brought about by an attempt to take some cathartic such as salts, but it is not persistent.

Diarrhea should be mentioned also, not as a special symptom of pelvic appendicitis but rather to draw attention to the fact that diarrhea is not uncommon in appendicitis.

The onset, therefore, is not different from that of any attack of appendicitis, and appendicitis is usually considered among the diagnostic possibilities. On examination, however, the findings are so atypical that reasonable doubt is thrown on this diagnosis. We find practically always a normal temperature, an abdomen that is flat and soft, and a total absence of rigidity. In these cases we may go over the abdomen again and again, with deep palpation, without an expression of pain or tenderness on the part of the patient. On consultation, these facts are always brought out by the physician in charge, in justification of his delay. It does not seem to be general knowledge that there is such a group of cases with these negative findings.

The fourth symptom which is often present in these cases, and usually overlooked, is irritation on urination. In most cases this point must be brought out by direct questioning, and when so done the patient will recall that he did have irritation on urination for a few hours, and perhaps frequency. In some cases the symptoms of irritation are dominant; and

[2] Short, A. R. Abdominal pain in children. Brit. M. J., 1935, 1: 1157.

[1] Read at the meeting of the Western Surgical Association, at Rochester, Minnesota, December 6–7, 1935

we have several on our list where cystoscopic and ureteral examinations were made in search of a diagnosis, although in each case appendicitis was considered possible in the early stages.

If the appendix is very low in the pelvis and underneath the bladder, there may be a rather constant desire to move the bowels,—so that we consider these two symptoms of importance: desire for urination, and desire to defecate.

On urine examination, red blood cells are frequently found in the urine. Ten to 20 cells are common. We believe that the appendix in such cases is often placed near the ureter, causing irritation; and that this finding should not be used to estop a diagnosis of appendicitis as has frequently been done.

The blood count is one of the most important single factors in diagnosis. The white count is usually high, 15,000 to 20,000, with a high polymorphonuclear count. In only a few of our cases has there been a low count, 8,000 to 10,000; but in such cases the polymorphonuclear count has usually been high.

We have, then, a patient who looks well, who gives a history of severe abdominal pain which after 12 hours has probably eased off, who has a normal temperature, a soft belly and absence of rigidity and tenderness, whose pain, when complained of, has localized itself usually in the left lower quadrant rather than on the right, who has had some symptoms either of urinary or rectal irritation, and who has a moderately high white cell count with an increased polymorphonuclear count.

Rectal examination is now of first importance to verify the diagnosis of pelvic appendicitis. While at the present time such examinations are more frequently made than in the past, I believe that many of them are really perfunctory. With the possibility of a pelvic appendicitis well in mind, this examination should be done thoroughly, preferably on a hard table. In a fat individual, it is difficult enough ordinarily, and with the patient in a soft bed becomes practically impossible. I would further urge that one examination is not sufficient. When seen early, the tenderness may not be made out with definiteness, and rectal examination should be repeated at least once or twice a day until a definite finding is made. In this way only can an early diagnosis be approached, and rupture of the appendix avoided.

Attention should be drawn to the fact that tenderness on rectal examination is noted early in those cases in which the appendix is low down in the pelvis; and is difficult to elicit where the appendix is just over the brim of the pelvis. In these latter cases, symptoms of rigidity and tenderness near Poupart's ligament come on fairly early, which helps in making a diagnosis.

The second 24 hours usually show a gradual and very moderate rise of temperature. If there has been no rise in the leucocyte count, there will be a definite rise in the polymorphonuclear count by this time; and if a Schilling count is made there will be found a distinct shift to the left. The left-sided pain may persist, but rigidity may still be absent. The severe pain usually diminishes; and the patient feels as if he should go to work, and resents being kept in bed. Finally when rupture occurs,—and this often is very sudden and unexpected,—the picture changes instantly. There is sudden severe pain, marked rigidity, and dullness over the right or left side, or both, and over the pubis,—all the signs of an intra-abdominal calamity.

In some cases the rupture is so sudden and the shock so great that epigastric pain makes the diagnosis of ruptured ulcer possible; but usually the symptoms are below the umbilicus. The bladder symptoms may increase. The rupture may be localized or it may be general.

In girls and young women, certain variants must be taken into consideration. In the first place, the appendix is frequently separated from the bladder by the broad ligaments and the uterus, and bladder symptoms and blood in the urine are found less frequently.

I should like to emphasize again the importance of the negative symptoms in the making of the diagnosis. It is customary on our surgical services to put as much stress on the negative findings of absent fever, and absence of pain and rigidity in a case that begins like appendicitis, as on the positive signs. Unless we make this type of appendicitis a distinct entity, these negative findings are misleading.

A discussion of acute pelvic appendicitis would not be complete without a careful consideration of the diseases which it is most likely to be mistaken for, or that may be mistaken for it. Three conditions have especially presented themselves to us: first, salpingitis; second, hemorrhage from an ovarian follicle into the abdominal cavity; and third, stone or gravel in the right ureter.

Probably more mistakes are made in the differential diagnosis of salpingitis than of any other one condition; and below I relate two interesting cases of this group. The early signs and symptoms of these two conditions can be very similar. In salpingitis the blood count may be higher, but it is not always so. Tenderness on both the right and left side may make one suspicious of tubal disease. We have found that our most reliable aid is the sedimentation time, and it should never be neglected. We agree entirely with the work of Lesser and Goldberger[1] who state that in cases of acute appendicitis, "in which, despite a definitely high leucocytic count, at operation such pathological states as catarrhal, suppurative, or gangrenous appendicitis were demonstrated, there was no deviation from the normal sedimentation reaction." The only forms of appendiceal pathology giving abnormal sedimentation reaction were those of well established abscess or generalized peritonitis of appendiceal origin. On the contrary, in acute adnexal disease the sedimentation time is markedly hastened.

I have also appended the histories of 2 cases of bleeding from an ovarian follicle, in which the possible diagnosis of pelvic appendicitis was considered. The symptoms may be very similar. Bladder or rectal irritation and pain on rectal examination are usually present. The variability in signs and symptoms on examination at different times is rather characteristic of this condition. Because of this variability, we have usually hospitalized such patients for observation; and again, if one remembers the not too uncommon occurrence of bleeding from ovarian follicles, diagnosis can often be ventured. Patients react differently to free blood in the peritoneal cavity. There are those in whom it causes a great deal of pain, with a high leucocyte count up to 35,000; in others these are not so marked. Bleeding, which comes usually from a pin-point area on the ovary, occurs from time to time; and symptoms are present only during the bleeding. This accounts for their variability. Ruptures seem usually to occur at or near the menstrual period. As said before, we believe that this condition is not very uncommon; that it occurs more often than we know, and is the cause of pain in the right or left quadrants in young women, suggestive of appendicitis, which clears up when bleeding has ceased. Not all the cases go on to massive hemorrhage, as has been found in our operative cases.

Stone in the ureter can be very misleading. We recently made a mistake on such a case. The pain of ureteral colic is usually more severe and demands a hypodermic, as it seldom does in appendicitis. This might give one the necessary clue. Also, the red blood cells in the urine are usually greater in number and more persistent. On suspicion, roentgen-ray studies should be made.

In the treatment of pelvic appendicitis, when this diagnosis is definitely made, it is customary for us to advise a right rectus incision, whereas ordinarily we definitely favor the McBurney incision for acute appendicitis; and furthermore, if rupture seems probable, as is often the case in this form of appendicitis, we believe that spinal anesthesia has great advantages. We feel quite sure that there is an added danger in removing an adherent or gangrenous appendix lying in the pelvis through a McBurney incision, even when the latter has been extended. We seldom, if ever, drain the peritoneal cavity in acute appendicitis; and in pelvic appendicitis we never drain. We may put small drains down to the peritoneum, but never into the peritoneal cavity. Secondary abscesses may form in the pelvis, but these are always easily opened through the rectum. The presence of drains adds many dangers and increases the mortality.

Let me repeat again that, while it may seem that there is very little to go on in making a diagnosis of pelvic appendicitis, it is our expe-

[1]Lesser, Albert, and Goldberger, Harold A. The blood sedimentation time and its value in the differential diagnosis of acute appendicitis. Surg., Gynec. & Obst., 1935, 60: 157.

rience that once one makes of this disease a mental and diagnostic entity, there will always be one or more clues at hand upon which a careful clinician can base a diagnosis.

At the present time there has been a very considerable effort to lower the mortality statistics of appendicitis; and emphasis has been laid on many factors which have helped. Everyone states, however, that no real advance can be made except through early diagnosis. It is axiomatic that when perforation occurs the death-rate rises; and—if my experience coincides with that of other surgeons—pelvic appendicitis ruptures more frequently than any other form because of delay in diagnosis. Therefore the early diagnosis of acute pelvic appendicitis, with prompt operation, will be the method par excellence of reducing the death rate.

CASE REPORTS

Pelvic appendicitis with rupture.

Mr. W., male, aged 55 years, rather stout and plethoric. Previous operations: infected pilonidal cyst, 1921; recurrent left inguinal hernia, 1928, followed by pulmonary infarct and venous thrombosis of both legs. At this time he had an acute cardiac decompensation. In 1931, he was treated for hypertension. At times he was cyanotic. Blood pressure was about 200. At the time of the present illness, however, his general condition was much improved.

His symptoms began Friday, November 2, 1934, at 2:00 a.m. He was waked out of sleep by severe abdominal pain, cramp-like in character. He walked about the room, unable to get comfortable. His physician in the morning found him without fever, with a pulse of 70; abdomen soft throughout, with no pain even upon the deepest pressure. The patient stated that he had had a desire to defecate, and went several times to stool without result. A laxative had been taken an hour before the doctor called. A diagnosis of possible appendicitis was made, but there was considerable doubt in the physician's mind. However, a nurse was sent to his hotel in order to avoid any mistake. At noon there was still no fever, but the patient was still in pain.

The following day the pain continued. Temperature was 99.2 degrees. Examination at this time discovered no change in the physical signs, but there was still pain in the lower abdomen, much more on the left than on the right side. When I saw him later he stated on direct questioning that he had had urinary symptoms at the end of the penis, and a desire to urinate.

There were, then, on Friday, the triad of symptoms which should have led to operation: sudden severe pain, pain on the left side more than on the right, urinary and rectal distress, and an absence of all tenderness and rigidity. Unfortunately, no blood count was taken until the next morning, at which time there were 20,400 leucocytes.

I saw this patient first in consultation at 6:00 p.m. on Saturday, November 3. Definite signs of rupture had by this time taken place. The entire lower abdomen was rigid on both sides, tense and tender. There was dullness over the symphysis, extending both to the right and left sides. The pains were not so severe as they had been, and he did not look sick. Temperature was 100 degrees. The leucocyte count was 26,500; polymorphonuclears 85 per cent. He was a fat man, and rectal examination was not satisfactory but was slightly confirmatory. Pelvic appendicitis with rupture was diagnosed, and he was immediately hospitalized.

Operation. Right rectus incision. The appendix lay over the brim of the pelvis, behind the bladder. The head of the cecum was bound down in the pelvis, and could not be elevated. When the peritoneal cavity was opened, thin pus was withdrawn with an aspirator, and became thicker as we came nearer to the appendix. The appendix was covered with fibrin and was necrotic and surrounded by thick creamy pus. There was no odor to the pus.

Smears from the peritoneal cavity showed no colon bacilli, but streptococci. Cultures later showed colon bacilli, streptococci, and staphylococci.

The next morning the patient was much better, remarked that he had great relief from pain, and seemed comfortable. In the afternoon, however, vomiting became severe, with great distention. Toward evening he became cyanotic and died at 1:00 a.m.

This man was a poor subject for any kind of peritonitis, and especially streptococcic peritonitis. He had marked cardiovascular disease, high blood pressure, and was very stout. He had, however, early in his disease the typical symptoms of pelvic appendicitis as we have drawn them.

Pelvic appendicitis with rupture.

F. N., male, aged 40 years, business executive. Physically, he was perfectly well on December 8, 1934, on arising. He had his usual bowel movement after a light breakfast. During mid-morning, at the office, he developed a dull, nagging pain in the midline above the umbilicus. The pain persisted steadily, although varying in intensity. He tried an alkaline powder, vomited twice, with considerable retching, small amounts of watery fluid. His bowels moved twice,—small amounts. He had some urinary distress and a little irritation at the end of the penis. The pain persisted, so that he came home about midday. He was seen at 2:00 p.m. by his physician, and at that time he complained of a steady moderate pain just above the umbilicus, spreading laterally. He was comforted by strong

local pressure. There was no rigidity, the abdomen was soft.

Temperature, 98.6 degrees; pulse, 94. General examination was negative. On abdominal examination his muscle wall was well relaxed everywhere. There was no tenderness over the area of indicated pain. There was some slight sensitiveness to light pressure in the area above the symphysis, extending about an inch to the right and 2 to 3 inches to the left. Peristalsis was present. No blood count was taken, probably because of the absence of rigidity.

At 6:00 p.m. he reported no change except a temperature of 99.6 degrees. He had vomited once in the afternoon. During the night his temperature rose to 101 degrees. He had considerable pain, and vomited once or twice, and soreness was now present across the lower abdomen. At 10:30 in the morning of December 9, about 24 hours after the onset, he was seen by a surgeon. At that time his temperature was normal, pulse was not rapid, and there was only questionable rigidity in the left lower quadrant. The blood count at noon was white blood cells, 22,000; and 86 per cent polymorphonuclears. At 1:00 the temperature was 100.5 degrees; pulse 96; and he again had pain across the upper abdomen, cramp-like. His abdomen was relaxed; there was no rigidity. There was noted sensitiveness to pressure above the symphysis and running to the left.

I saw this patient at 6:00 p.m., with a temperature of 99.8 degrees; pulse, 104. The patient was bright, active, and said he felt better than at any time since the onset. He thought he might be able to go to the office in the morning. All his upper abdominal pain had gone. Sensation of lower abdominal pain was almost gone. He was not nauseated.

When I examined him, however, there was tenderness and resistance on the right side; and on rectal examination he was found to be definitely tender on the right side, and one could feel guarding of the muscles rectally. The medical attendant who made rectal examination was not able to verify this, but I felt sure that there was definite resistance and greater tenderness on the right side.

It was difficult to persuade both the patient and the doctor in charge that operation was necessary, and that, immediately. A diagnosis was made of pelvic appendicitis with probable rupture. On his entrance into the hospital, the physician in charge even delayed the operative procedures until I should see the patient again, thinking that operation might not be necessary; and told the family that if the blood count was lower he would advise delay. Fortunately, the blood count at the hospital was 27,940 white blood cells with 89 per cent polymorphonuclears (filamented neutrophiles 69 per cent, non-filamented 31 per cent). It was not difficult, therefore, for me to persuade the physician that operation was essential at the time. I am sure, however, that if the blood count had been around 12,000 to 14,000, it would have been difficult to persuade him that the patient was not getting well; and such a count is possible.

A right rectus incision was therefore made for a pelvic appendix. Immediately the peritoneum was opened, free thin purulent fluid was present, which spilled over the wound. As we walled off the ileum on one side, and the cecum on the other, deep in the pelvis lay a red fibrinous appendix attached to the terminal ileum by fibrin. The end of the appendix was necrotic and contained a small perforation. The peritoneal fluid became thicker as we neared the appendiceal area.

The appendix was removed the usual way, and the wound closed, the peritoneum being sewed with a double layer of catgut and the skin and fascia by a figure-of-eight mattress of silkworm gut, with rubber drains down to the muscle between each stitch.

This patient made a perfect recovery. The wound healed without suppuration except for a little serum discharged on the fourteenth day; and patient was discharged from the hospital with a strong abdominal wall.

Pelvic appendicitis with rupture.

I. G., male, age 12½ years. On Saturday, February 2, 1935, he was indiscreet in his diet; and Saturday night had abdominal pain for which ex-lax was given. On Sunday, February 3, he was awakened with severe abdominal pain and vomiting.

On the following day, Monday, February 4, his physician was called; and he was found to have a temperature of 100.4 degrees, 17,000 leucocytes, and 79 per cent polymorphonuclears. There had been no further vomiting. On examination, there was no rigidity. His abdomen was perfectly soft throughout, but he complained of some urinary frequency. No rectal examination was made.

On February 5, the boy felt perfectly well. He was without pain, but his temperature was 100.4 degrees. On Wednesday, February 6, he felt fairly well. His bowels had moved each day. The doctor felt that he was on the road to recovery.

On February 7, he began to have intermittent pain, and finally abdominal cramps with nausea and vomiting. His temperature rose to 39.8 degrees. His leucocytes, however, were only 11,000, with polymorphonuclears 75 per cent, 68 per cent of which were non-filamented. That evening, on entry into the hospital, his white cells were 8,000, with 70 per cent neutrophiles.

At this time, however, we discovered a child in very great pain. His legs were drawn up, he was obviously ill and feverish. His throat was reddened and injected. He was rigid over the entire abdomen, especially in the epigastrium. Rebound tenderness was present. Rectal examination showed great tenderness on the right, with some rigidity.

A diagnosis was made of a perforated pelvic appendix and peritonitis. Therefore a right rectus incision was made. Free purulent fluid was found. Cultures and smears were taken. The appendix lay deep in the pelvis, densely adherent to the sigmoid and freed with difficulty. Several ounces of pus were found around the appendix. The appendix was found to be gangrenous and ruptured.

The patient had a stormy convalescence. Bilateral scrotal abscess formed which had to be opened and drained; but no abscess formed in the pelvis, which we thought might occur, and the patient made a recovery. He was discharged on the twenty-ninth day.

This patient had an appendicitis extending over several days, the symptoms beginning February 2, operation on February 7. The symptoms were intermittent, but I believe diagnosis was possible, first, by the leucocyte count on the first day; the urinary frequency; the absence of rigidity. Rectal examination in this case probably would have played considerable part in clinching the diagnosis. The leucocyte count, however, was misleading, later coming down to 11,000 and finally, with entry into the hospital, to only 8,000.

Pelvic appendicitis with rupture. General peritonitis. Death.

J. M. Male, aged 44 years. This patient was seen in consultation September 25, 1935, and gave the following history. He called upon his physician on Friday, September 20, stating that he had had abdominal pain. This was first noticed after a rather heavy dinner on September 18, 2 days previously. Pain was intermittent, mainly in the upper abdomen. For 2 nights following the onset of the pain he had had very little sleep and ate sparingly. He did not vomit. The bowels acted daily.

On examination at this time, Friday, September 20, patient had a temperature of 100 degrees, pulse, 100; and blood pressure, 140/80. Throat and lungs were clear and there were normal heart sounds. The abdomen was not distended, only slight tenderness on pressure over the entire abdomen. There was no rigidity and no rebound tenderness. Rectal examination did not reveal any masses nor did it cause pain. The prostate was somewhat hypertrophied and smooth.

He was sent to the hospital, however, with a tentative diagnosis of appendicitis. That evening blood count showed 8,800 leucocytes and 68 per cent polymorphonuclears. The following morning blood count was 8,700 leucocytes with 67 per cent polymorphonuclears. The patient reported that he slept well, no pain had occurred during the night. On examination the abdomen was soft to palpation and not tender. On account of the general and local improvement in his symptoms and the normal blood count a very favorable prognosis was given.

On Saturday, September 21, 3 days after the onset, at 1:30 p.m. the patient had a sudden, severe abdominal pain, passed into shock and was cyanotic. The blood count at this time was 18,200 leucocytes and 55 per cent polymorphonuclears.

Operation was performed immediately through a right rectus incision; fetid purulent material escaped as soon as the peritoneum was opened. The appendix lay in the pelvis adherent to the under surface of the terminal ileum, was grayish in color and friable. The appendix was removed and one drain was placed down to the pelvis and another alongside of the cecum. The wound was closed loosely about the drains.

The patient was at first improved then went on to a general peritonitis, with foul discharge from the wound. Polyvalent anaerobic serum was given, also continuous intravenous drip and hot applications. Distention increased and the patient died at 6 p.m. September 26, of general peritonitis arising from an acute suppurative appendicitis.

This patient was seen in consultation after operation.

Several points in this case should be emphasized. The low blood count, the soft abdomen and the absence of rigidity made the diagnosis doubtful and was dependent upon the fact that the appendix lay in the pelvis and was covered by the ileum and was probably difficult to palpate by rectal examination. Repeated rectal examinations, however, might have been suggestive. This case also brings out the point that when the diagnosis is not made early in these cases it often becomes more difficult as time goes on because of the amelioration of symptoms, and then with sudden rupture there is, of course, no doubt as to the pathology. The suddenness of the rupture in this case, with shock and cyanosis, suggested the possibility of perforated ulcer to the physician in charge. Attention should also be drawn to the fact that in patients over 40 years of age the prognosis is much worse when general peritonitis occurs than in young adults and children.

Pelvic appendicitis with rupture.

Mrs. O. T., female, married, graduate nurse, age 24 years. Entry December 8, 1935. One year ago the patient had an attack of right lower quadrant pain, lasting 2 days, subsiding with bed rest alone. Six months later she had a similar attack, which subsided with a couple of days of bed rest. Her last menstrual period was 3 weeks prior to entry.

Patient entered Ward One at 11:00 p.m., December 8, 1935, with the history that she had been perfectly well until Saturday, December 7, 1935, at which time, in the afternoon, she developed bilateral lower abdominal pain, followed in 3 to 4 hours by nausea and vomiting. She vomited twice. At 10:00 p.m. that night she had a diarrhea consisting of five liquid yellow bowel movements which continued through the night. The next morning she

felt slightly better, went without breakfast, and returned to the ward to do her work. The abdominal pain persisted in both the right and left lower quadrants; was steady in character, and did not radiate. She had several liquid bowel movements during the day. In the afternoon the pain became so severe that she was forced to go to bed. The pain was constant in character and not intermittent or cramp-like.

On examination at this time, by the medical resident, the patient was found to have a temperature of 100 degrees, pulse, 100; respirations, 22. Heart and lungs were negative. The skin seemed to be slightly icteric. The abdomen was flat, entirely soft. No viscera or masses were palpable. There was tenderness on deep pressure in both the right and left lower quadrants with rebound tenderness in the same areas. Peristalsis was very active. No pelvic or rectal examination was made.

Diagnosis of acute gastro-enteritis with complicating catarrhal jaundice was made.

The urine was entirely negative. The red blood cells numbered 4,600,000; hemoglobin was 90 per cent; white blood cells 18,400; polymorphonuclears 91 per cent. Stool sent to the laboratory for culture.

During that night the patient ceased to have any bowel movements and was constipated during the rest of her illness.

On Monday, December 9, 1935, the patient's temperature rose to 103 degrees, pulse to 120. There was slight rigidity in both the right and left lower quadrants, peristalsis was still very active. On rectal examination there was tenderness in both right and left fornices, perhaps a little more tender on the right. She had some discomfort and pain on motion of her cervix.

At 9:00 p.m. on December 9, 1935, bimanual examination was made by Dr. George K. Rhodes. A very tender mass could be palpated in the cul-de-sac. The patient gave a history of two very definite chills, each lasting about 15 minutes, with a profuse perspiration afterward. The first chill occurred Sunday afternoon. The second chill occurred at 6:00 p.m. Monday, December 9, 1935, shortly after the first rectal examination. Patient had a very slight burning on urination. A diagnosis of pelvic appendicitis was made.

Operation through a low midline incision revealed a gangrenous ruptured appendix, the tip in the cul-de-sac of Douglas. Purulent fluid was found in the pelvis, and there was considerable peritoneal fluid, cloudy, in the general peritoneal cavity.

The appendiceal mesentery was not remarkable.

The appendix was removed; the abdomen was closed with a single Penrose drain placed down to the peritoneum. Good recovery.

In this case the delay in diagnosis was made, first, because of the diarrhea, which was misleading; second, because the resident did not wish to examine the patient vaginally; and third, because of the misleading sign of a soft abdomen which made the diagnosis of appendicitis improbable. However, it is interesting to know that this patient, in our own hospital, went on to rupture before the diagnosis was made. Our surgical side, however, wishes to point out that the case did not come to their notice until after rupture had occurred and the diagnosis made easy.

Difficult diagnosis between pelvic appendicitis and salpingitis.

Mrs. I. B., age 23, married. Menstruation always irregular. The last period was 2 weeks ago, lasting 6 days, rather heavy. Has never been pregnant. Has had no discharge. She had been constipated for 5 years, requiring catharsis once or twice a week. Her sleep has been good, but she turns night into day, her husband being a night-club operator.

On November 1, 1935, the patient was awakened with violent pains at 3:00 a.m. These pains were across the lower abdomen, as much on the left side as on the right, were cramp-like in character and lasted about 2 hours. At 10:00 a.m., as soon as she got out of bed, the pains recurred as before, across the lower abdomen. She took one teaspoonful of Epsom salts and vomited almost immediately, but repeated the dose and retained it.

The patient remained in bed for the next 4 days without seeing a doctor, the pain being intermittent. On November 3, 3 days after the onset of pain, she had violent cramps in the lower abdomen, as much on the left as on the right.

On November 4, her physician was called at 4:30 p.m. At this time her temperature was 98.6 degrees, pulse rate, 92; respirations, 22. Her white count was 19,800; large monocytes 18 per cent; polymorphonuclears, 78 per cent; eosinophils, 4 per cent; segmented, 70 per cent; stab, 7 per cent; juvenile, 1 per cent; myelocytes, 0 per cent. Urinalysis entirely negative, no red blood cells.

On examination, she was tender to palpation in both lower quadrants, but there was no rigidity and no spasm over any part of the abdomen.

When I saw the patient in consultation, on November 4 at 6:00 p.m., she was sitting in bed looking very well, and she said that she felt very much better. On questioning her she stated that during one day she had had a great deal of irritation and frequency of urination, but this had passed away.

There was no rigidity anywhere, and her tenderness was not very marked even to deep palpation, but was present especially on the right side over the right ovarian region near Poupart's ligament. On flexing the thigh, there was more tenderness on the right side. On vaginal examination, there was a definite fullness and tenderness over the right side, but no masses could be palpated. There was slight tenderness over the left fornix. The uterus could be moved without pain.

The differential diagnosis here between an acute pelvic appendicitis and a salpingitis was very difficult. The decision was made mainly on the normal temperature, which would be unusual in salpingitis; the absence of rigidity, also unusual in salpingitis; and the sedimentation time, which was normal.

Operation was advised, which Dr. Daniel Sooy did immediately; and he removed a distended gangrenous appendix lying low in the pelvis. The appendix was unruptured. The patient made an uncomplicated recovery.

Pelvic inflammatory; symptoms similar to appendicitis; sedimentation time diagnostic.

Mrs. E. C., female, aged 46 years, married. Hospital entry November 27, 1935. This patient had been operated upon in 1930 for an ovarian cyst. It was not known whether or not the appendix had been removed at this operation. She entered the hospital and gave the following history:

For 4 days prior to entry she had experienced abdominal pain originating in the right lower quadrant, radiating to the left quadrant, and after 48 hours becoming generalized. The pain was described as being of a sharp, shooting character, sufficient to make her cry out and to keep her awake at night. There was no associated nausea or concomitant emesis. There were no thermometric readings at home; and at the hospital the temperature was 38 degrees; pulse, 84; respirations, 18.

Physical examination showed a well developed and nourished woman lying quietly in bed, complaining, however, of pain in the lower abdomen. Tenderness to palpation in the right lower quadrant over McBurney's point, with marked rebound tenderness. Some guarding in both lower quadrants. Midline incisional scar. No definite rigidity. Rectally no tenderness could be felt. Pelvic examination revealed moderate pain on movement of the cervix. Cervix was boggy, with yellowish discharge coming from the external os. Hemoglobin was 74 per cent; red blood cells 4,400,000; leucocytes 12,650; polymorphonuclears, 77 per cent; lymphocytes, 18 per cent; monocytes, 5 per cent (filamented 70 per cent; non-filamented 30 per cent).

The house-staff felt that this was a case of appendicitis, but Dr. Franklin Harris thought that this was more likely a pelvic inflammatory condition. Sedimentation time was therefore done:

6 mm.	12½ min.
12 mm.	21 min.
24 mm.	45 min.

This reading was too rapid for a diagnosis of appendicitis, and further suggested pelvic inflammatory disease. However, as there was some doubt, an exploratory operation was done. Adhesions were freed from the previous operation. The appendix had been removed, together with the left ovary and tube. The right tube was found to be markedly injected and plastered to the cecum at the site of the appendectomy by dense adhesions. The ovary was atrophic and not involved. The peritoneal contents were inflamed. The tube was freed from the cecum, and the abdomen was closed.

Diagnosis: Pelvic inflammatory disease; acute salpingitis of the right fallopian tube.

There was a reasonable doubt in this case between salpingitis and appendicitis, but the sedimentation time gave the real differential.

Pelvic appendicitis—diagnosis made. No sedimentation time taken, but would have been valuable.

V. H., female, aged 27 years. Hospital entry November 14, 1934. She was seen at 3:00 a.m. with a pain about the level of the umbilicus, which had begun 4 hours before. It was very severe, and extended into the right flank. She had vomited several times.

Examination of the abdomen failed to reveal any tenderness or rigidity. Even on deep palpation no pain could be elicited. There was no tenderness in her flank or at the costovertebral angles. There was no peristalsis to auscultation.

This patient gave a history of a similar attack in Boston 8 months before. At that time she was kept in bed, and she was told that she probably had an appendicitis.

Vaginal examination revealed tenderness behind the uterus. The adnexa were normal. Rectal examination: There was extreme tenderness in the cul-de-sac. White blood count, 25,000; 90 per cent polymorphonuclears. On admission to the hospital, temperature, 37.2 degrees; pulse, 120; respirations, 24.

Dr. Howard Stephens made a diagnosis of pelvic appendicitis, and advised immediate operation. A lower right rectus incision was used. An acute inflamed appendix was found lying in the pelvis, tensely distended. On examination, the specimen was found to be acutely inflamed, and the lumen filled with pus. No rupture had occurred.

The patient was discharged on the ninth day after operation.

This case illustrates an early diagnosis of appendicitis which might have been delayed, in other hands, for more definite symptoms; and which would probably have resulted in rupture. Operation was performed about 6 hours after onset, the appendix being already markedly diseased.

Ruptured ovarian follicle with bleeding into the peritoneal cavity. Previous attacks; not operated upon.

Miss B. B., aged 35 years. Hospital entry February 7, 1935. For the past week and a half, the patient had had a cold and sore throat. Three days before entry into the hospital, she had had low abdominal pain with pain in the rectum on passing stool; and this had persisted. The pain in the lower abdomen increased in severity, and the day previous to entry, she was somewhat nauseated and dizzy,

TABLE I.—APPENDECTOMIES, MOUNT ZION HOSPITAL, 1922–1934

	Number	Deaths	Per cent
Clinic cases—			
Acute appendicitis, including 55 cases of perforation, peritonitis, and abscess formation	211	4	1.9
Subacute appendicitis	131	0	0
Total	342	4	1.2
Private cases—			
Acute appendicitis, including 212 cases of perforation, peritonitis, and abscess formation	745	37	4.9
Subacute appendicitis	221	0	0
Total	966	37	3.9
Total acute private and clinic cases	956	41	4.2
Total subacute private and clinic cases	352	0	0
Total	1308	41	3.1

TABLE II.—SAN FRANCISCO HOSPITAL APPENDICITIS MORTALITY STATISTICS

Type	Description	Cases	Deaths	Per cent
1	Acute, simple	355	3	0.84
2	Gangrenous, non-perforated	256	5	1.9
3	Gangrenous, perforated	202	18	8.8
4	Appendiceal abscess	187	10	5.3
Total		1000	36	3.6

but was able to continue her work as a physiotherapist. Weakness and pain continued until Monday, and she was compelled to go to bed.

Dr. Howard Stephens was called. The symptoms were indefinite. She had no rigidity, but there was tenderness more or less generalized over the abdomen. Her temperature was normal. Her hemoglobin was 69.3 per cent; red blood cells, 3,600,000; leucocytes, 12,400; monocytes, 4 per cent; lymphocytes, 8 per cent; polymorphonuclear leucocytes, 87 per cent (filamented, 76 per cent; non-filamented, 24 per cent).

She gave a history at this time of attacks similar to this one about once a year for the past 8 or 10 years, which she stated were indistinguishable from this one. All her previous attacks had occurred around the time of her menstrual period. She had recovered each time without surgical interference.

She was operated on the following day with a low midline incision. She was found to have a ruptured follicle with blood and clots filling the peritoneal cavity. She made an uninterrupted recovery.

Diagnosis here should have been considered, with a low hemoglobin and red count, the weakness and dizziness coming on irregularly, and similar attacks occurring during the time of her previous menstrual periods.

Ruptured ovarian cyst with hemorrhage into the peritoneal cavity simulating pelvic appendicitis.

Miss E. G., aged 23 years. Admitted February 8, 1935. She was awakened about 4:00 a.m. on February 8 with a sudden, sharp lower abdominal pain. This pain was soon replaced by a dull ache, which became generalized throughout the lower abdomen. There was no point of marked tenderness. She was nauseated and vomited once.

When examined at 8:00 a.m., she was still complaining of pain. There was very slight tenderness in the lower right quadrant, and some indefinite muscle guarding. No urinary symptoms were present. The patient was in the second day of her menstrual cycle, which was normal in character.

Because of the doubt in diagnosis, the patient was sent into the hospital for observation. During the next 24 hours she continued to have dull aching pain, off and on, sometimes on the right and then it would again shift to the left. Her white blood count fluctuated between 7,000 and 15,000. The patient did not appear to be acutely ill at any time.

Toward evening the patient began to vomit, and this continued from time to time on the following day. At times the abdomen was soft and pliable; at other times it was quite rigid. The temperature was normal throughout the day.

When I saw the patient at 10:30 a.m. on February 9 in consultation with Dr. Groper, the abdomen was flat. There was no active peristalsis; no masses were seen or felt; and palpation revealed a comparatively soft abdomen with some tenderness low down on the right and left sides. Rectal examination did not elicit any pain. The uterus was freely movable. There was very definitely increased tenderness in the right flank. At this time the white blood count was 12,500. Blood pressure: 122/70.

Operation was advised, with the probable diagnosis of pelvic appendicitis, but with reservations. A right rectus incision was made by Dr. Groper. On opening the abdominal cavity, it was found to be full of blood, the source of which was evidently a small cyst in the right ovary. This ovary was as large as a mandarin orange, and contained a single large cyst which had ruptured.

I am appending Tables I and II, showing the statistics for appendectomies done at the Mt. Zion Hospital, at which I have the surgical service, and at the San Francisco Hospital, which include cases operated upon both by the University of California and Stanford University surgical services. The latter is a large general hospital where the cases are frequently brought in late, sometimes moribund, and where all of the emergency work of the city of San Francisco is done. I have to thank Dr. Frank Harris for the statistics at the Mt. Zion Hospital. Many of these

patients were operated upon by him and other members of the surgical staff. I also wish to extend my appreciation to Dr. George Rhodes for the statistics at the San Francisco Hospital.

These studies are quoted because in recent years there have been published similar statistics from various clinics throughout the United States. In some of them the mortality for perforation and peritonitis has been so high that there has been a distinct tendency to advise operative delay in acute cases when the patients come in after the third day. We do not agree with this thesis and still believe that the usual operation should be done when the diagnosis is made.

INTERVALS BETWEEN PREGNANCIES OF MOTHERS GIVING BIRTH TO CONGENITALLY MALFORMED CHILDREN

A Study of 531 Families[1]

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In a previous report, it was shown that the pregnancies which end in miscarriages, stillbirths and premature births—of mothers who bear congenitally malformed children—tend to occur close to the pregnancy which results in the birth of the defective child (1). This finding suggested: (a) that at the latter time, these mothers are wont to experience more or less prolonged periods of reproductive inefficiency, and (b) that such intervals of time are sufficiently long to permit more than one conception to take place.

The present study also deals with this period of reproductive inefficiency of mothers who give birth to congenitally malformed children. It concerns the length of the non-pregnant period which precedes the conception of the malformed child, and is of interest, especially in the light of the findings which resulted from the above mentioned study.

MATERIALS AND METHODS

To quote from a previous communication (2), the material forming the basis for both the present study, and the one mentioned, was secured in the following manner:

"There were found in the files of the Bureau of Vital Statistics, Department of Health of the State of Pennsylvania, 130,132 death certificates for stillborn and liveborn individuals who died in Philadelphia during the 5 years between January 1, 1929, and December 31, 1933. Each of these certificates was examined, and the data on those noting the existence of any congenital defect were transcribed to duplicate, official forms; 1,476 such certificates were located.

"The deceased individual was considered to have possessed a defect under either of two conditions: (1) if the defect involved the surface of the body, or (2), if internal, if its presence had been disclosed by operation or necropsy. Diagnoses not conforming to these requirements were considered as not verified and were excluded from further consideration. This procedure reduced the number of usable certificates to 890, or only 60 per cent of the original 1,476 certificates.

"An attempt was made to interview the mother of each of the 890 deceased individuals, the visits being made in the summer of 1934 by 3 fourth year medical students, now Drs. Dorothea Killian, Tracy Cuttle, and Milton Mazer, assisted by Edward Durkin. A complete reproductive history was secured from each mother who could be located. The group forms a consecutive series. The defective children all died within a given geographic area and in a given period of time."

Among the questions asked the mother of each defective child were the following: (a) year and month of marriage, (b) year and month of each delivery, and (c) duration of each prematurely interrupted pregnancy.

From the answers to these questions, the lengths of the non-pregnant intervals preceding each conception of these mothers were counted in months. In those cases in which a pregnancy was preceded by another pregnancy, the intervening interval was measured from the month of the preceding delivery to the month of the following conception. In event of a first pregnancy, the interval was counted from the month of marriage to the month of conception. In case the mother married twice and had children by both husbands, the interval for the first child by the second husband was measured from the time of the second marriage.

In a few instances, mothers could not give the exact duration of prematurely ending pregnancies. In these cases, miscarriages were estimated as having occurred at the end of 3 month periods, and premature births, at the end of 7 month intervals. With these facts then, it was possible to determine the

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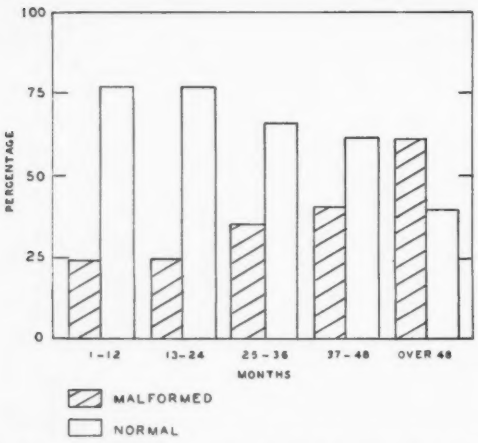

Fig. 1. Graphic presentation of data appearing in columns 4 and 6, Table I. Base line indicates non-pregnant intervals in months, vertical line records percentage of pregnancies. Note tendency for pregnancies ending in malformed offspring to follow the longer non-pregnant intervals, and especially where the intervals are very long.

lengths of the non-pregnant intervals in months, which preceded the conceptions of both the congenitally malformed offspring and those of their normally developed siblings (brothers and sisters).

THE DATA

The lengths of the non-pregnant intervals were determined for 2,146 pregnancies which occurred in a consecutive series of 531 families. Of the 2,146 pregnancies, 584 terminated in the birth of congenitally malformed children, and 1,562 in the birth of their normally developed brothers and sisters (Table I). The diagnoses of the 584 malformed offspring are given in Table II. In this connection, it is of interest to know that the malformations involved the body surface in approximately 80 per cent of cases, and that approximately 90 per cent of the malformed individuals died within 1 year of birth.

The number and percentage of pregnancies ending in the birth of congenitally malformed children can be compared with similar figures for their normally developed siblings in Table I, arranged according to the lengths of the non-pregnant intervals. The percentage relationship between the two distributions also

TABLE I.—NON-PREGNANT INTERVALS BETWEEN PREGNANCIES

Intervals in months	Pregnancies				
	All	Ending in:			
		Malformed children		Normal siblings	
		Total	Per hundred of all pregnancies	Total	Per hundred of all pregnancies
Number (1)	Number (2)	Number (3)	Number (4)	Number (5)	Number (6)
1–12	1213	285	23.5	928	76.5
13–24	547	130	23.8	417	76.2
25–36	189	66	34.9	123	65.1
37–48	79	31	39.2	48	60.8
49–60	50	33	61.2	17	38.8
61–72	26	14		12	
73–84	12	6		6	
85–96	3	1		2	
97–	27	18		9	
Totals	2146	584		1562	

Showing distribution of 2,146 pregnancies of a consecutive series of 531 mothers who gave birth to congenitally malformed children, arranged according to lengths of preceding non-pregnant intervals. Note in columns 1 and 4 the direct relation between increasing length of preceding non-pregnant intervals and the percentage of pregnancies ending in the birth of malformed children. Also observe the large proportion of the latter which were preceded by non-pregnant intervals of more than 48 months, as compared with their normal brothers and sisters as shown in column 6.

TABLE II.—CLASSIFICATION OF DIAGNOSES

Body system	Children	
	Number	Per cent
Reported	584	100.0
Nervous	408	70.0
Gastro-intestinal	83	14.2
Cutaneomusculoskeletal	63	10.7
Monsters not described	18	3.1
Urinary	7	1.2
Respiratory	1	.1
Ill defined	4	.7

is expressed graphically in Figure 1. From these data, it is apparent (a) that the malformed children had a tendency to be born after longer non-pregnant intervals, on the average, than were their normally developed brothers and sisters, and (b) that an exceed-

ingly large number of malformed offspring were born after non-pregnant intervals of more than 4 years' duration.

As the home visitors turned in their reports, it was noted that a very long non-pregnant interval frequently preceded the birth of the malformed member of the family. For example, it was quite common in the case of large families to note intervals of 2 to 3 years between normal children and then an interval of 6 or 8 years preceding the birth of the malformed child, followed again by short intervals between subsequent, normally developed children. It was the frequent repetition of this observation which led to the presentation of the figures given here.

The reason why such long, non-pregnant intervals preceded the conceptions of so many of the congenitally malformed children in these families, is not known. A partial explanation for this phenomenon is possible, on the basis of the observations presented in the previous paper (1). As was mentioned there, the parents of congenitally malformed children appear to exhibit a period of reproductive inefficiency, about the time in their reproductive life that they give birth to their malformed children. This period is characterized by the frequent failure of these parents to reproduce full term, living and normally developed offspring. It would seem reasonable to assume, that, during this same period, many germ cells are produced, which not only are incapable of giving rise to full term, living and normally developed offspring, but also ones which are entirely incapable of becoming fertilized. Hence, although germ cells are produced, they do not become fertilized, and so no offspring appear.

SUMMARY AND CONCLUSIONS

1. The lengths of the non-pregnant intervals preceding the conceptions of 2,146 offspring of a series of 531 women, each having a congenitally malformed child, were determined.

2. The non-pregnant intervals preceding the conceptions of 584 congenitally malformed children were found to be significantly longer than the same intervals for their 1,562 normally developed brothers and sisters.

3. This observation, and ones presented in a previous paper, tend to support a theory, to the effect that mothers of congenitally malformed offspring are wont to experience a more or less prolonged period of reproductive inefficiency, at the time that their congenitally malformed offspring are born.

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THE EFFECTS OF CALCULOUS BILIARY OBSTRUCTION ON THE STRUCTURE AND FUNCTIONS OF THE LIVER[1]

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FROM a theoretical standpoint it would appear that the effects of stone in the common duct on the structure and functions of the liver should be, respectively, predictable and measurable, and that knowing in a given case the duration and relative completeness of biliary obstruction, one should be able to estimate the degree of hepatic pathological and physiological change with a fair degree of accuracy.

The facts, however, seem to be somewhat at variance with this hypothesis; if one examines the records of a series of patients with choledocholithiasis, it is apparent that there are too many variable factors to allow for an easy solution. Many stones remain latent in the ducts for long periods and cause damage to the biliary system and hepatic parenchyma before producing definite symptoms. It is also known that the ability of the liver to withstand biliary obstruction is by no means constant in different individuals, and that the properties of the liver in respect to regeneration and repair vary over a wide range, depending on the patency of the biliary system and the maintenance of adequate blood supply. Even if the pathological changes induced in the liver by calculous biliary obstruction were constant, which they certainly are not, is there any means of determining the presence or measuring the extent of such changes? A completely affirmative reply cannot as yet be given, but at least it is possible to obtain considerable information which may serve as a guide to treatment and prognosis.

The pathology of both experimental and clinical biliary obstruction is not a new subject, but it is still not well understood nor generally appreciated. For example, it is difficult to correlate the gross disease of the liver seen by the surgeon with the microscopic appearance of the organ and the actual extent of destruction of hepatic tissue. Biopsies are not an entirely reliable help in this connection, since they represent only a small sample of a large organ. There are also certain obvious objections to basing conclusions on necropsy material alone, the principal one being that it includes chiefly advanced hepatic lesions. However, by a comparison of surgical descriptions with the available microscopic material from all sources, it is possible to come to some tentative conclusions in regard to the degree of hepatic damage present in the individual case. This plan is, of course, subject to criticism, but it is reliable in one respect: there is little disagreement between pathologists and surgeons as to the nature of the more serious grades of hepatic disease.

In reviewing a series of 63 recent cases of jaundiced patients with stone in the common duct, verified surgically or at necropsy, and comparing it with a similar series reported in 1932 (10), the pathological lesions appear to fall into 4 groups, the first representing uncomplicated calculous obstruction and the 3 remaining the more serious complicating lesions in the liver. These cases may be classified as follows: (1) those with minimal gross and microscopic hepatic lesions and only slight evidence of disturbances in the functions of the liver, (2) those in which severe ascending biliary infections play a major part in the destruction of the hepatic parenchyma, (3) those in which the liver undergoes a process of acute or subacute atrophy and degeneration following obstruction to the duct, and (4) those characterized by either advanced hepatitis with beginning fibrosis or by the development of actual cirrhosis.

In the current series (chiefly of cases seen during 1935) the hepatic damage was considered to be slight or moderate in about two-thirds of the whole group, while in about a third there was gross evidence of marked structural changes. Cases in the first and

[1]Read before the meeting of the Chicago Surgical Society, Chicago, Illinois, February 7, 1936.

largest group, in which only the effects of simple, uncomplicated biliary obstruction are apparent, are chiefly those with a relatively short history of biliary colic and slight transient jaundice at the time of examination. The biliary passages were patent in every instance, and visible jaundice was either slight or in the process of subsiding, the average level of serum bilirubin being about 3 milligrams per 100 cubic centimeters. The surgeon, in describing the gross appearance of the liver as seen at operation, mentioned chiefly the localized perihepatitis in the fossa of the gall bladder and, occasionally, the increased firmness of the liver, its rounded edge, and its indistinct markings. Discoloration from retained bile pigment producing a muddy, brownish hue was sometimes apparent. Not many microscopic preparations from such livers are available, but they show chiefly slight atrophy of the cells about the central veins of the hepatic lobule, scattered bile thrombi, areas of bile pigmentation in the cells in the central zones, and occasional small collections of lymphocytes about the portal spaces. In certain of these cases in which the liver was not remarkable grossly a considerable degree of cirrhosis was already apparent on microscopic study.

In the second group, that in which cholangeitis played a dominant rôle, a febrile course, deeper and more persistent jaundice, and intermittent occlusion of the bile passages were characteristic. On the average the serum bilirubin was higher (8 to 15 mgm. per 100 c.cm.) and there was little variation from day to day. Hemorrhagic features and renal insufficiency were common in these cases. The surgical record frequently called attention to the engorged and cloudy appearance of the liver, to the presence of purulent material in the bile ducts, and to the frequent association of pancreatitis. Microscopic preparations in such cases revealed, in addition to the signs of biliary obstruction just mentioned, a greater degree of parenchymal destruction, with leucocytic collections in and about the finer bile passages and portal spaces. Often, abscesses were present, which were most frequently miliary but which were at times of considerable size.

In the third group of cases, which were fortunately not often encountered, the clinical picture was that of icterus gravis following an episode of biliary colic. The distinguishing features of these cases have been described in earlier papers (11); the most striking clinical symptom was the extreme degree of jaundice persisting without particular reference to the patency of the bile passages. The levels of serum bilirubin were high (15 to 20 mgm. per 100 c.cm.), a hemorrhagic tendency was often noted, and hepatic insufficiency was an early development. Since few of the more advanced cases have come to operation, available descriptions of the liver come largely from material at necropsy. The liver was often enlarged, firm, greenish, and showed areas of reddish or yellow mottling; in occasional cases a flabby, friable, atrophic liver was found. Microscopically the picture was that of extensive destruction of hepatic tissue; often whole lobules were destroyed and it was difficult to find anything more than remnants of the normal structure. Extensive fatty degeneration was frequently noted. Some of the less advanced cases of this type were observed at operation, and in these the striking features were the Paris-green color of the liver, its abnormal consistency, the presence of white bile in the ducts, and the difficulty in controlling bleeding.

The fourth group is comprised chiefly of cases in which individuals have for various reasons suffered from intermittent and incomplete biliary obstruction over longer periods of time. Partially patent bile passages, slight constant jaundice, and an enlarged firm liver and spleen are the distinguishing clinical features. Hepatic insufficiency and cholemic bleeding were not as common as might be supposed, and in fact many individuals appear to have an unusual tolerance to obstructive cirrhosis. The liver in numerous cases was described by the operating surgeon as frankly of the hobnail type; perihepatitis and cholangiectasis were common findings, and in a few instances there were even signs of portal obstruction.

Microscopically, the appearance of the hepatic parenchyma in "biliary cirrhosis" was virtually indistinguishable from that in the

ordinary non-obstructive forms. The lobules of the liver were outlined by connective tissue proliferation, and there was often distinct adenomatous formation with gross disorganization of the hepatic structure. Bile staining of the hepatic cells, dilatation of the intrahepatic bile passages, and patchy areas of atrophy were usual accompaniments of the process. In some cases, by appropriate stains fairly extensive deposits of fat were shown.

It should not be inferred that these four groups are absolutely distinct and characteristic; as a matter of fact, combination forms are noted commonly, both in the more chronic and severe cases and in some of the supposedly uncomplicated cases in which the cirrhotic process was occasionally well under way. Suppurative cholangeitis or acute degenerating hepatitis may supervene in any type of biliary obstruction, without respect to its duration or the previous condition of the liver. Cholangiectasis may also be a factor, particularly in association with large impacted stones or following repeated episodes of partial obstruction, but it is of much less importance than in cases of biliary obstruction from neoplasm. The time factor in the development of secondary hepatic lesions is important; while one sees extensive acute or subacute degenerating lesions at any stage of biliary obstruction, the actual gross appearance of cirrhosis was uncommon except following long continued interference with the flow of bile.

From the pathological standpoint one may conclude that in about two-thirds of cases of calculous biliary obstruction the hepatic lesions are of a relatively minor and temporary nature and of such a character as to present no great obstacles to recovery; in the remaining third, more serious complicating lesions are encountered which are characterized by various degrees of degenerative or destructive lesions in the hepatic parenchyma, by proliferation of connective tissue and cirrhosis, by cholangiectasis and cholangeitis, or by combinations of all three. These pathological changes are reflected to a considerable degree in disturbances in function, which may be demonstrated in various ways, and as a rule one may form certain conclusions as to the probable degree of hepatic damage from such tests. As a general rule the three more serious types of hepatic damage just mentioned cannot always be clearly distinguished one from the other by clinical or laboratory means, and in discussing the effects of these lesions on hepatic functional tests they are best considered as a group.

In the first and larger group of patients who present the picture of uncomplicated temporary biliary obstruction and who are usually classified by the operating surgeon as having minor grades of hepatitis (grade 2 or less), the only hepatic functions which are particularly affected are those that control the excretion of bilirubin and such dyes as bromsulphalein. As stated in an earlier paragraph, the average level of serum bilirubin in this group of cases at the time of operation was about 3 milligrams per 100 cubic centimeters. In a few cases seen immediately following colic a peak of 6 to 8 milligrams per 100 cubic centimeters was attained; but, within a day or so, a much lower figure was recorded. In a number of such cases the retention of bromsulphalein was graded 1 to 3, especially when the test was performed shortly following colic. Since it is known (1) that the hepatic cell takes up dyes poorly during or immediately following an episode of biliary obstruction, this finding is of little importance and does not signify hepatic damage of the degree indicated. Occasionally a positive Takata-Ara test was noted; this also can be discounted to a great extent since the test is not by any means a specific indication of the presence of cirrhosis (4), as some writers have intimated. In other words, a low figure for serum bilirubin following an isolated, recent attack of biliary colic is of itself reasonably good assurance of a hepatic parenchyma that is to all intents and purposes competent at that particular time. Under these circumstances further hepatic functional studies are not likely to give much additional information of value. An exception must be made in the cases of patients who give a long history of repeated colic and slight variable icterus, since in these cases there may be chronic hepatic damage of considerable extent in spite of a minor degree of bilirubinemia.

In the three groups in which more serious hepatic damage is present, such damage is, as has been said previously, traceable to cholangeitis, to extensive degenerative hepatitis, to the development of biliary cirrhosis, and, rarely, to interference with the portal blood supply. In these cases the widest possible range of disturbance in hepatic function has been recorded, and to avoid confusion the results are best evaluated by considering the individual functions themselves. The general metabolic properties of the liver are not as a rule greatly disturbed, even by destruction of a considerable portion of its parenchyma, the assimilation and utilization of carbohydrate, protein, and fat being maintained within physiological limits. The only disturbances of carbohydrate metabolism which are of importance are two: (1) there may be an increased excretion of galactose in the occasional case with acute cellular damage, and (2) hypoglycemia may occur among patients with extremely fatty, cirrhotic livers. The only significant changes in protein metabolism are those pertaining to the level of plasma proteins, a matter which will be considered separately; a low value for blood urea is uncommon and only rarely have studies on the partition of urinary nitrogen shown significant variations from normal (13). The relation of the liver to fat metabolism is virtually an unexplored field. It is known that biliary obstruction, even if of fairly short duration, will produce a marked rise in blood cholesterol and cholesterol esters and, conversely, that progressive hepatic damage will result in an equally striking fall of these substances; in cases of acute or subacute atrophy of the liver the cholesterol esters may be reduced to extremely low levels. None of the foregoing changes are of clinical importance and can rarely be used as a guide to prognosis.

For practical purposes the most valuable information on the state of the hepatic parenchyma of the patient with calculous obstruction may be obtained from three sources, namely: studies of the excretory functions, of the detoxifying functions, and of the "manufacturing" functions of the liver. The first implies principally a consideration of the levels of serum bilirubin and their fluctuation. It has long been a rule of thumb that deep jaundice following biliary colic meant a badly damaged liver. For instance, in the series of cases under consideration, every patient who had a level of serum bilirubin maintained at 8 milligrams per 100 cubic centimeters or higher had gross visible hepatic damage of considerable degree at operation. In the individual case it is difficult to say just how much of this rise in bilirubin represents obstruction of the bile ducts alone and how much represents the damming back of normally formed bilirubin because of damage to the hepatic cells themselves. It is rare that the common duct is completely occluded by stone, so that the high levels for serum bilirubin cannot be explained on this basis. There is some indirect evidence, based on photelometer determinations of bilirubin (7), which indicates that bilirubinemia due to obstruction alone rarely exceeds 5 to 8 milligrams and that any increment above this is due to failure of bilirubin (giving the indirect van den Bergh reaction) to pass the hepatic cell. In other words, increases above the average level for uncomplicated obstruction furnish an index of hepatic damage.

The studies of Watson on the excretion of urobilinogen furnish an interesting corollary to this theory; he has shown that in uncomplicated choledocholithiasis the urinary excretion of urobilinogen is within normal limits, whereas in cases with associated cholangeitis or cirrhosis the liver fails to take up the chromogen, and it is eliminated in large quantities in the urine. Whatever the explanation of the increase in serum bilirubin in complicated cases of common duct stone may be, there is no disagreement as to its significance. In this field theory and practice agree; the mortality of surgery in cases of calculous biliary obstruction lies largely, as one could predict, in the group of deeply jaundiced patients.

Among the most useful of the hepatic functional tests from the standpoint of prognosis is one which is based on the detoxifying ability of the liver, specifically on its ability to conjugate benzoic acid with glycine and thus form hippuric acid. In man, the site of this synthesis is presumed to be the liver, and the

excretion of hippuric acid has therefore been taken as a measure of hepatic function. Because of the necessity of being certain that the hippuric acid is eliminated at a normal rate by the kidney, the test cannot be relied on unless renal function is approximately normal. Positive tests (an excretion of less than 3 grams of hippuric acid during a period of 4 hours after a test dose of 6 grams of sodium benzoate has been administered) are an excellent indication of a damaged liver, and in a fair number of cases we at the clinic have noted, as have also Quick and Vaccaro, that there is a rough, inverse quantitative relationship between the degree of hepatic damage and the amount of hippuric acid synthesized. The test is not infallible and both positive and negative errors have been recorded; however, it may be said that if the elimination of hippuric acid is reduced to 50 per cent or less, the operating surgeon almost invariably finds a badly damaged liver with evidence of acute or subacute hepatitis and cirrhosis. Here again there is agreement between the theoretical and the practical, the mortality figures in a small group of cases seeming to bear out the contention that a strongly positive hippuric acid test indicates a grave surgical risk.

Other hepatic functional studies which give information of value with regard to the state of the hepatic parenchyma following calculous obstruction are those which pertain to the formation of blood proteins. All four of the blood proteins, fibrinogen, hemoglobin, serum albumin, and serum globulin, have been studied in connection with hepatic injury. Fibrinogen is known to be an exclusive hepatic product and low values have been encountered in hepatic disease, but since infection or injury to tissue have been found to increase the amount of fibrinogen in circulation, the determination of this substance has been of little value for diagnostic purposes. The relation of the liver to hemoglobin formation and function is a newer and more promising field. It has recently been shown by Whipple and his collaborators that, "the liver participates in active fashion in the preparation of parent substances for hemoglobin production," and the same investigators (9) have demonstrated by biologic assay that there is a great reduction in the factors which produce hemoglobin in certain types of diseased livers. This was true particularly if hepatic insufficiency was present before death. These findings seem to indicate that hepatic disease interferes with the production of hemoglobin, which is in accord with the well known macrocytic anemia of portal cirrhosis. At the clinic we have repeatedly noted that, in the presence of stone in the common duct and secondary biliary cirrhosis, macrocytic anemia of considerable degree may be present and that its presence is indicative of advanced parenchymal destruction.

We have recently been concerned with the occurrence of anoxemia in hepatic disease (12), and since there are no cardiorespiratory factors to explain it adequately the question was naturally raised as to whether the hemoglobin is altered qualitatively as well as quantitatively by hepatic injury. While the results of the investigation thus far are not conclusive, it seems possible that under certain conditions this may be the case. In 3 cases of stone in the common duct and associated parenchymatous hepatic injury it was noted that anoxic anoxemia was present, and that in one case the hemoglobin did not become completely saturated with oxygen in the usual manner, either *in vivo* or *in vitro*. The dissociation curve of oxyhemoglobin obtained in this case was distinctly abnormal, thus suggesting that hemoglobin sometimes may be functionally altered in respect to its ability to transport oxygen in the presence of hepatic disease. The presence of an active reducing agent in the blood of such patients has not been excluded.

Variations in the serum proteins, albumin, and globulin have been noted for some time in the presence of hepatic disease, and the relation of such variations to hepatic functional disturbances rests on a sound experimental and clinical basis. While there is no direct proof that the liver is the sole site of manufacture of serum proteins, experimental studies furnish some indirect evidence of their hepatic origin. Recent work in Whipple's (2, 3) laboratory indicates that there is a reserve of protein building material in the

TABLE I.—HEPATIC FUNCTIONAL TESTS IN VARIOUS TYPES OF OBSTRUCTIVE JAUNDICE

Patient	Hemoglobin, gm. per 100 c.cm.	Erythrocytes, millions	Serum bilirubin, mgm. per 100 c.cm.	Serum protein, gm. per 100 c.cm.	Albumin-globulin ratio	Galactose excretion, gm.	Cholesterol, mgm. per 100 c.cm.	Cholesterol esters, mgm. per 100 c.cm.	Takata-Ara test	Hippuric acid, gm.	Arterial oxygen saturation, per cent	Plasma coagulation index	Hepatic changes (surgical note)	Outcome
Bo	12.3	3.89	13.2	7.0	1:1.24	1.3	225	119					Moderate hepatitis, "good bile" in common duct	Recovered
Ma	13.8	4.10*	5.3	7.0	1.34:1		345			2.2		1.0	Moderate changes	Recovered
Ti	9.9	3.69	8.3	6.55	1.02:1	Neg.	735	416	Pos.	4.16		0.78 0.85	Hard block-like liver and hepatitis	Recovered
Gr	14.4	4.11	11.1	6.11	1:1.12	Tr.			Pos.	1.72	89.5		Hepatitis, grade 4+	Recovered. Much residual hepatic damage
Hwd	11.4	3.20*	8.8	6.3	1:1.12		211	85	Pos.	0.41			"Hobnail liver"	Recovered
Mi	9.6	3.44*	7.9	7.1	1:1.3	1.03	416	252		3.62	88.4		Cirrhosis grade 2+	Previous stricture and stones in duct; died

*Macrocytosis.

organism which is stored, at least in part, in the liver and which is probably at least 50 per cent albumin or albumin producing material; and these investigators believed that there is probably a dynamic equilibrium between tissue and plasma protein, in which equilibrium the stored material in the liver may figure.

There is a long series of reports on the relation of hepatic disease to the level of serum protein (5), and it has been observed repeatedly that in advanced chronic hepatic lesions, particularly in portal cirrhosis, there is a moderate reduction in the total serum proteins, the diminution occurring chiefly in the albumin fraction with reversal of the albumin-globulin ratio. In less advanced cases, the albumin may be only moderately reduced and the globulin may be normal or increased in amount. In any type of hepatic disease, however, the effects on the albumin-globulin ratio are somewhat the same. In some cases of hepatic damage due to stone in the common duct studied at the clinic, albumin-globulin ratios as low as 0.5 have been observed. In others, with less serious hepatic injury, the changes in the ratio are not as marked or constant and the variations noted tend to return to normal as improvement takes place. The rapidity with which changes in the total serum protein and in the albumin-globulin ratio may take place is rather striking, and repeated determinations in the same case and in experimental studies on animals indicate that these changes reflect in a general way the course of the hepatic lesion. In clinical subjects it has been noted that very low albumin-globulin ratios are found only in cases in which obstruction of the common duct has seriously damaged the hepatic parenchyma, and for this reason it appears that determinations of the serum proteins and the albumin-globulin ratio may be of considerable value in prognosis. In this connection it should be noted that the development of ascites in the occasional case of biliary cirrhosis may depend on reductions in serum albumin, the factor shown to be most important in maintaining the osmotic pressure of serum.

The extent to which the results of the various hepatic functional tests can be correlated one with the other and with the degree of hepatic damage described by the operating surgeon is shown in Table I. It is apparent that the deviations from normal as determined by the various methods of study do not necessarily parallel one another, but that on the whole this situation is approached in the more chronic and severe hepatic lesions. The

greatest and most constant abnormalities are noted in patients with obstructive cirrhosis, and in this group the danger signals of hepatic dysfunction are easily recognized. In such cases, the pathological and physiological findings are in accord; in the acute degenerative forms of hepatitis and in ascending biliary infections, the most constant evidence of progressive destruction of hepatic tissue is the high and constant bilirubinemia.

In neither the acute or chronic forms of hepatitis secondary to calculous obstruction are there any hepatic functional tests which accurately foretell the tendency to cholemic bleeding, the best advance evidence of this catastrophe being given by Nygaard's method of determining the index of plasma coagulability. What makes the jaundiced patient bleed, or what the basis of hepatic insufficiency may be, are the two questions which every surgeon would like to have answered. There is no clue as yet which promises an immediate solution to either problem and speculation on the subject is hardly warranted. That the two phenomena are closely allied can hardly be doubted; they may depend on the liberation of some substance from degenerating hepatic tissue or on some as yet undiscovered abnormality in the physicochemical properties of blood induced by hepatic damage. Until these two major problems in the field of biliary surgery are settled, studies in the pathology and physiology of hepatic disease should not be abandoned.

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A THERAPEUTIC STUDY OF BROMSALIZOL IN CHRONIC ARTHRITIS

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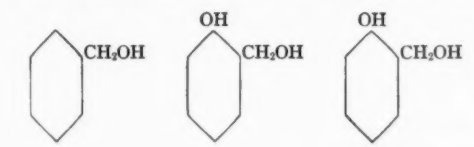
BROMSALIZOL, or mono-brom saligenin, is a chemical compound described by Macht and Dunning in several previous communications (3, 4, 5, 6, 7). Pharmacological study of this drug revealed that it possessed two striking physiological properties: (1) a local anesthetic effect and (2) an antispasmodic action on smooth muscle tissues and organs. It was furthermore discovered that the toxicity of bromsalizol was very low, another finding which warranted its therapeutic trial. Such a study, undertaken by a number of physicians, indicated that the drug was effective in clinical conditions characterized by colic-like pains and other symptoms produced by spastic condition of smooth muscle tissues. These cases included particularly such diseases of the gastro-intestinal tract as pyloric spasm, spastic conditions of the small and large intestine and gall-bladder colic, dysmenorrhea or colic due to spasm of the uterus, and a number of urological conditions, especially spasm of the bladder, seminal vesicles, and ureters (8). Later reports from numerous physicians in various parts of the country confirmed the original findings.

The chemical structure of this compound is shown below. Bromsalizol is mono-brom saligerlin, a derivative of saligenin or hydroxy benzyl alcohol. Saligenin is found in nature in the glucoside known as salicin, which was used by the old physicians in



benzyl alcohol — saligenin — 2oxy 5 brom benzyl alcohol (Bromsalizol)

treating rheumatic affections (1). The compound is closely related to salicylic acid, as a comparison of the formulas given will show. Because of the therapeutic value of the salicylates and of salicin as antirheumatics, it was deemed worth while to conduct an investigation for the purpose of determining whether or not bromsalizol afforded any relief in arthritic cases.

ANIMAL EXPERIMENTS

It is not possible to produce an arthritis experimentally, neither is it possible to make an accurate comparison of such pain relieving drugs as the various antipyretics by the use of animals. In the pharmacological laboratory, however, we could and did obtain indirect experimental evidence indicating that bromsalizol exerts on the central nervous system an action very similar to that of the salicylates and other antirheumatic drugs. Such indirect evidence was derived from experiments on animals with fever, animals with convulsions of cerebral origin, and animals with general anesthesia.

Fever was produced in rabbits and guinea pigs by various methods as, for instance, by injecting them with hay infusion. The action of bromsalizol, administered by stomach to these experimental animals, was then investigated. It was found that bromsalizol, like the salicylates and other antispasmodic drugs, produced a definite, though not very marked, lowering of the temperature. This finding is illustrated by the following protocols.

Rabbit No. 17, weighing 2 kilograms, previously injected with hay infusion.

11:18 a.m. Temperature, 104 degrees F.

11:25 a.m. Injected intraperitoneally 20 cubic centimeters (100 milligrams) of 0.5 per cent solution of saligenin.

12:20 p.m. Temperature, 104 degrees F.

2:00 p.m. Temperature, 104 degrees F. . . . No antipyretic effect.

Rabbit No. 18, weighing 2 kilo, previously injected with hay infusion.

11:20 a.m. Temperature, 104 degrees F.

11:25 a.m. Injected intraperitoneally 15 cubic centimeters of 0.5 per cent solution of bromsalizol.

12:20 p.m. Temperature, 100 degrees F.

1:00 p.m. Temperature, 101 degrees F.

2:00 p.m. Temperature, 104 degrees. . . . Antipyretic effect and recovery.

Guinea pig No. 1, weighing 420 grams, previously injected with hay infusion.

2:00 p.m. Temperature, 103.3 degrees F.

2:05 p.m. Injected intraperitoneally 50 milligrams of saligenin.

3:00 p.m. Temperature, 103 degrees F.

Guinea pig No. 2, weighing 440 grams, previously injected with hay infusion.

2:10 p.m. Temperature, 104 degrees F.

2:15 p.m. Injected intraperitoneally 50 milligrams of bromsalizol.

3:00 p.m. Temperature, 102.8 degrees F. . . . Antipyretic effect.

The antipyretic effect of bromsalizol could be demonstrated only in animals with hyperpyrexia, or temperature above normal. The temperature of normal rabbits could not be lowered to a subnormal degree even by doses of 10 grains administered by stomach.

A second series of experiments gave further proof that bromsalizol exerts a mild sedative action on the central nervous system. In these experiments, convulsions of the cerebral type were produced by injecting guinea pigs, rats and mice with solutions of camphorated oil; and a study was made to determine whether or not bromsalizol antagonized such convulsant action. The effect of bromsalizol, or mono-brom saligenin, on camphor convulsions was compared with that of the mother substance, saligenin itself. It was found that saligenin alone exerted very little antagonistic action on the convulsions but that bromsalizol had a definitely sedative and anticonvulsant effect. This action is illustrated by the following protocols.

Guinea pig No. 3, weighing 420 grams.

9:55 a.m. Injected intraperitoneally with 50 milligrams of saligenin.

2:25 p.m. Injected intraperitoneally with 50 milligrams of saligenin.

2:57 p.m. Injected 1 cubic centimeter of camphorated oil (U.S.P.)

3:03 p.m. Violent convulsions.

3:20 p.m. Repeated clonic and tonic convulsions.

3:30 p.m. Moribund.

4:15 p.m. Dead.

Guinea pig No. 4, weighing 430 grams.

9:58 a.m. Injected intraperitoneally with 50 milligrams of mono-brom saligenin (bromsalizol).

2:30 p.m. Injected with 50 milligrams of bromsalizol.

3:00 p.m. Injected with 1 cubic centimeter of camphorated oil (U.S.P.).

3:08 p.m. Tremor.

3:10 p.m. Mild convulsion.

3:20 p.m. Sitting up; no convulsion.

4:00 p.m. Mild convulsion.

4:15 p.m. Quiet.

Next day. Recovered.

Further evidence of the sedative effect of bromsalizol on the central nervous system, and particularly on the brain, was obtained in experiments on such small animals as rats and mice. Large doses of bromsalizol, injected in these animals, produced a hypnotic effect. Having thus been put to sleep, they remained anesthetized for many hours. If the dose was not excessive, they eventually regained consciousness and were apparently in sound health a few days later.

Rat, weighing 150 grams. Injected intraperitoneally with 10 cubic centimeters of 0.5 per cent solution of mono-brom saligenin (bromsalizol), in physiological saline. Hypnotic effect produced; recovery in 3 hours.

Mouse, weighing 24 grams. Injected intraperitoneally with 1 cubic centimeter of 0.5 per cent solution of bromsalizol. Deep anesthesia; partial recovery in 6 hours; complete recovery overnight.

Such a general anesthesia could not be obtained in experiments on larger animals—guinea pigs, pigeons, rabbits, cats, and dogs—even with very large doses of the drug. Nevertheless the experiments on small animals indicated that bromsalizol has a sedative effect on the brain, including the pain areas.

THERAPEUTIC EXPERIENCES

Inasmuch as the salicylates and salicin have proved efficacious in relieving rheumatic or arthritic pains and the experiments with bromsalizol described indicated that in some respects it has on the central nervous system an action like that of the salicylates, it was deemed worth while to make a study of this drug on a series of clinical cases, especially since it has a very low toxicity. Such a study was made on a series of clinical cases suffering from arthritic pains of a chronic type, and the effect of bromsalizol on such patients was compared with that of acetyl salicylic acid and various other antipyretics.

Doses of from 5 to 10 grains of bromsalizol were administered three times a day to each of a series of one hundred ambulant cases

complaining of arthritis. More than 75 per cent of these patients were definitely relieved of their rheumatic pains, and a comparison of the action of bromsalizol with that of acetyl salicylic acid revealed that the stomachs of these patients tolerated the former better than the latter. Indeed, some of the patients selected for this study took bromsalizol because they had suffered gastric irritation from previous administration of ordinary salicylates. Data regarding the ambulant cases mentioned have been obtained from a number of practicing physicians. A detailed description of this series of cases is omitted because the object of the present paper is primarily to set forth the results obtained in a carefully controlled study of the effects of bromsalizol on chronic arthritics under the constant supervision of doctors and nurses.

Female patients with inveterate arthritic manifestations were selected for this investigation of the effect of bromsalizol on chronic arthritis cases at the Home for Incurables, Baltimore. The action of bromsalizol was carefully compared with that of several other drugs, often without the knowledge of the patient. Bromsalizol was administered in doses of 10 grains three times a day, and sometimes oftener. The drug was usually given in tablet form but in some cases, to distract the attention of the patients, it was administered in capsules. For further control, such capsules were occasionally interchanged with capsules of sodium bicarbonate. Attendant nurses carefully recorded on charts the effect of bromsalizol not only on pain but also on blood pressure, temperature, urine, gastro-intestinal tract and general condition and behavior of the subjects.

RESULTS

The total number of patients studied was 24, most of them well past middle age. The cases were selected especially for their persistent and uncontrollable arthritic pains. The medication previously employed included all kinds of coal-tar derivatives and also codeine. The effects of such drugs were compared with those of bromsalizol. The results are classified as follows.

No effect was noted in 5 cases out of the 24. The treatment had to be discontinued in other cases because one suffered from a psychosis, a second refused to co-operate and take the drug, a third complained of nausea after its ingestion and a fourth developed a genito-urinary condition from another cause and was accordingly considered unsuitable for such an experimental study. Ten of the remaining cases, or 42 per cent of the total number, were definitely relieved; and 5 patients, or 21 per cent, showed marked relief. A favorable therapeutic action was thus noted in 63 per cent of all the cases.

Another finding made in connection with this study was that the effect of bromsalizol on the temperature was nil except in one case. This patient had a slight fever and bromsalizol lowered the temperature one degree. This negative finding was not surprising because all the other patients had a normal temperature and antipyretics in general, unless they are given in toxic doses, do not lower normal temperatures (2).

It was found, moreover, that bromsalizol had no effect on *normal* blood pressure. In patients suffering from hypertension, however, bromsalizol effected a reduction in both systolic and diastolic pressures. There was an accompanying relief in symptoms due to high blood pressure, such as palpitation of the heart and headache. Thus, for instance, one patient who before treatment showed a systolic pressure of 210 millimeters and a diastolic pressure of 120 millimeters, afterward gave a reading of 160/102. Curiously enough, another patient, whose blood pressure was below normal, or 101/72, before she was treated with bromsalizol, afterward gave a reading of 140/81. This rise in blood pressure was probably due to an improvement in her general condition and relief of her suffering.

With regard to the effects of the drug on the gastro-intestinal tract, it may be noted that one case of constipation, of the spastic type, was strikingly relieved by bromsalizol. This, of course, was a manifestation of the antispasmodic effect of the drug on smooth muscle viscera. The patient's constipation, which was of a decidedly spastic character, was therefore relieved by the drug.

SUMMARY

A clinical study of the effects of bromsalizol, or mono-brom saligenin, on the pains of chronic arthritis in a series of 24 adult and old women revealed that a total of 63 per cent experienced some degree of relief. Twenty-one per cent of these gave evidence of marked relief; 42 per cent showed definite but not absolute relief. The action of bromsalizol on these patients was compared with that of other antipyretics and in some cases with that of codeine. The relief experienced was equal to that induced by the other medicaments used, and in some cases bromsalizol proved to be even more satisfactory than any of the other drugs. Similar results were obtained in a study of a series of ambulant cases. Compared with sodium salicylate, and acetyl salicylic acid, especially, bromsalizol produced little or no irritation of the stomach; indeed, the drug was well tolerated by patients who could not take either of the other drugs on account of gastric irritation. Such a result was to be expected because of bromsalizol's antispasmodic or sedative action on smooth muscle viscera. No objectionable by-effect was noted in any of the series of patients treated with bromsalizol and the authors consider this finding alone sufficient to warrant a more extensive trial of the drug in clinical practice for the relief of arthritic pains, especially those of a chronic character.

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A CONSIDERATION OF THE NUTRITIONAL STATUS OF THE SURGICAL PATIENT[1]

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A COMPREHENSIVE analysis of the nutritional status of the surgical patient indicates that many patients at the time of operation are in a state of malnutrition due either to a deficient food intake or to their inability to utilize injested nutritional elements. Such a nutritional disbalance embraces actual food deficiency as well as dehydration, stages of avitaminosis, and mineral deficiency. Under ordinary circumstances the average American, due to comparative accessibility to essential food stuffs, will not display a definite deficiency syndrome unless the period of subtotal starvation is prolonged. However, experience indicates that a considerable number of postoperative complications which increase the patient's discomfort and add to the morbidity, if not to the actual mortality, can be attributed to faulty nutrition.

A study of nutritional status in health and disease is not a simple matter since the body has the ability to compensate for many of the transitory deficiencies of food intake. The situation is amply expressed by McLester: "The organs of the body and the tissues and fluids that make up these organs are in a wonderfully steady state of equilibrium, so much so that when the organism is deprived of anything essential this balance is profoundly disturbed and the entire mechanism upset. To the preservation of this mechanism at all times and in the face of all the vicissitudes to which man is subject many factors contribute, some of these simple in nature, some exceedingly complex, some large, some exquisitely small."

In evaluating the nutritional requirements for the specific individual there must be considered the caloric values of the food elements —protein, fats, and carbohydrates—the essential vitamins, minerals, and water. Water intake so as to assure a complete water balance has been stressed during the past few years and it need only be mentioned here as an essential in the proper nutrition of the patient. It may not be out of place, however, to mention two phases of water balance as it applies to the surgical patient. One is the insensible water loss. Coller has called attention to this and estimates that the average loss of water during the first 4 hours after a major surgical procedure is 1 liter. This includes loss of blood, urine, evaporation from tidal air, perspiration, and the vomitus. About 70 per cent of this amount is represented by perspiration and tidal air vapor. He states that the amount may be increased to 3000 cubic centimeters by fever. The second phase is concerned with replacement in the event of need of considerable amounts of water. Since the subcutaneous or intravenous methods are the ones usually employed, the water is administered in the form of physiologic salt solution. I have known instances in which 4000 to 6000 cubic centimeters of salt solution have been given during a period of 24 hours. This means that from 36 to 54 grams of salt are given to the patient during a period of 24 hours when the normal need is only approximately 15 grams. In the presence of kidney disease, a crisis may be precipitated by such indiscriminate introduction of salt.

In the consideration of the nutritional status of the individual, the six "pillar aspects" of Sherman are deserving of mention. They are: "(1) the energy aspect, (2) the proteins and their amino acids, (3) the mineral elements, (4) the vitamins, (5) the interrelations among these different factors, and (6) the principle that our most significant concern is with the nutritional reactions of the living body as a whole—as a co-ordinated whole which, in some respects at least, is something more than a mere summation of its parts."

The science of nutrition has taught us that the average individual in a state of rest requires 25 calories per kilogram of body weight to supply the necessary energy for his basal metabolism. With activity or when the basal

[1] Read before the Utah State Medical Society at Logan, Utah, September 5, 1935.

metabolism is raised by fever or metabolic disturbances, such as may be produced by hyperthyroidism, the need materially increases. This energy is supplied by the basal food stuffs—fats, proteins, and carbohydrates. By the consumption of these food stuffs when supplied in adequate amounts, the body is supplied with the proper amount of fuel for oxidation processes. When excess amounts are taken, there is a storage in the form of glycogen deposits in the liver and muscles, and deposits of fat. A moderate amount of the latter is desirable since it constitutes a reserve supply of fuel for emergency use and offers protection to organs and structures as well as a mechanical support to organs. The latter is concerned with visceroptosis and allied diseases.

The properly balanced diet should consist of the basal food elements in such proportions as to maintain a normal relationship of essential values. It has been stated that an excess of one type of food with a marked deficiency or absence of another is more harmful than the withdrawal of all food. This applies especially to protein deficiency with a high carbohydrate intake. This observation is especially significant when we consider how often the surgeon attempts to nourish a devitalized patient after operation by giving glucose intravenously. A state of protein deficiency no doubt is an important factor in many surgical patients. The average restricted diet is poor in protein, in fact is far below the necessary nitrogenous requirements. Minot is of the opinion that sundry disorders may be attributed to a protein deficient diet; he cites a case in which it is his opinion that the prolonged coagulation time of the blood was due to nutritional deficiency. It is pertinent to note the marked change in the attitude of the internist toward protein intake in forms of nephritis. In the nephrosis cases in which large quantities of albumin are lost in the urine, it is essential that the protein diet be increased rather than decreased so as to supply the body with sufficient nitrogenous material. Minot believes that in some cases of albuminuria, the deficient protein intake may be an etiological factor and that a primary kidney disease is not present, the albuminuria being the result of a lowered threshold of the kidney associated with defective nutrition. Furthermore, it is interesting to note that the modern conception in treating the pregnant woman is, because of the inordinate drain upon her body proteins leading to edema and allied conditions, toward an increase in the protein diet rather than a curtailment. Protein deficiency manifests itself in sundry ways, such as edema, dry harsh skin, transitory attacks of mild icterus, loss of weight and strength, mental stupor, decreased resistance to disease (McLester), and the like. Just how many of the distressing symptoms encountered in the surgical patient can be accounted for on the basis of protein starvation is yet a question; however, it is my impression that protein deficiency plays a much greater rôle in the morbidity and mortality than we believe or can prove.

Carbohydrate food substances are supposed to be readily digested and easily metabolized, and therefore are the common constituents of the dietary for a surgical patient. There is no question but that this is true; however, they must not be given to the exclusion of proteins and fats. Carbohydrate food stuffs supply readily available energy and the excess is stored in the liver and muscles in the form of glycogen. This reserve store of glycogen is not excessive for it is known that, with complete withdrawal of carbohydrates and those foods from which the body can build carbohydrates, the liver glycogen will be exhausted within 18 hours. After this period of time, the necessary carbohydrates must be metabolized from the living body tissues and at the expense of the body economy. It is a growing impression that the extensive and prolonged drainage of the body tissues to make available adequate energy producing elements is detrimental to its integrity. It might be stated that 58 per cent of protein and 10 per cent of fat can be metabolized into carbohydrates in the body, but that protein can not be built from carbohydrates or fats; therefore, the necessary proteins must be either supplied extraneously or be withdrawn from the body proteins.

Space will not permit entering into an extensive discussion of the vitamins; how-

ever, there is no question but that forms of avitaminosis play a definite rôle in the surgical patient. Perhaps in the average undernourished patient, a vitamin deficiency plays a greater rôle than actual food deficiency. McLester has noted that in the guinea pig a period of time elapses between the actual exhaustion of the vitamin C reserve and the appearance of scurvy, during which time pathological changes are taking place. He believes that the same situation obtains in man and that there is constant need of a vitamin C supply because without appearance of actual scurvy, changes similar to those in the guinea pig occur which impair resistance for intercurrent infections. In a report of excellently controlled experiments McCarrison concludes that sinusitis, otitis media, gastroduodenal ulceration, forms of goiter, and urinary calculi frequently occur in animals fed an ill balanced diet containing little or no vitamin A bearing food. He states: "In my experience these food materials"—raw milk, butter, cod liver oil, carrots and fresh green vegetables—"when suitably combined have protected my animals from these diseases and I do not doubt that in the hands of the surgeon they will go far to protect his human patients from them and facilitate their cure and non-recurrence after operation." McCarrison further calls attention to two points of interest to the surgeon: (1) If rats, fed on a diet low in vitamin A be infected with paratyphoid bacilli they usually die from the infection. In those that recover, the infection persists in the lymph glands for a long time after the general infection has been overcome. He infers that enlarged lymph glands in the human may be the result of persistence of infection as the result of a vitamin A deficiency diet. (2) There are breaches in the walls of defense against bacterial invasion consequent to the use of vitamin A deficient diets also that other vitamins may exercise an anti-infective action. He cites the observations of Arnold:

"The pathological examination of the dead animals following avitaminosis experiments shows evidence of tissue changes due to infections of various kinds. We have found that one of the first demonstrable changes in avitaminosis is an alteration in the distribution of the bacterial life within the lumen of the intestinal tract. The bacteria ingested by the mouth are not destroyed in the usual manner, but remain viable for many hours within the contents of the whole length of the small intestines. The mixed bacterial flora of the large intestines ascends into the upper levels of the small intestines. There is a gradual and progressive loss of the power of the body surface to control the microbic life existing in contact with it. These findings have been constant and hold for vitamins A, B, and D deficiencies. By the time the adult animal shows a loss of body weight or the young animals show a stationary weight curve, there is evidence of bacterial invasion of the mucosa of certain surfaces. These latter observations have been made by numerous investigators. We attribute the early inflammatory changes in the lining membranes of the eye, mouth, throat, alimentary tract, etc., to the loss of power of these body surface coverings to regulate the bacterial flora in contact with their cells. This precedes evidence of invasion of the membrane by bacteria."

More recent observations seem to indicate that vitamin A deficiency causes a change in the character of the epithelium lining the respiratory, alimentary, and genito-urinary tracts, also the eye. "The normal epithelium undergoes metaplasia or is replaced by stratified keratinizing epithelium" (Wiggers). This change is, no doubt, due to the lack of vitamin A. Wiggers believes that this accounts for the eye changes, the formation of renal calculi, and that the altered epithelium of the respiratory and alimentary tracts has lost its power to resist bacterial invasion, thus accounting for respiratory infections and gastro-intestinal disturbances. Be the mechanism what it may, all experimental evidence points to the fact that in vitamin deficiency, especially vitamin A deficiency, there is a decided tendency toward a breakdown of the resistance to infection involving especially the respiratory and gastro-intestinal tracts. This fact should be of more than passing interest to the surgeon in view of the frequent postoperative respiratory infections and gastro-intestinal disorders.

There are several significant facts concerning vitamin B deficiency. It is known that anorexia is a prominent symptom of vitamin B deficiency; in fact, this is so striking that many observers have concluded that all of the typical symptoms of vitamin B deficiency can be accounted for on the basis of malnutri-

tion incident to incomplete starvation. The polyneuritis due to vitamin B deficiency may be a confusing factor in dealing with certain types of neuritis and arthritis encountered in the human.

Vitamin D deficiency is associated with calcium metabolism. Sherman states that "probably about one-tenth of the American families not consciously underfed were nevertheless subsisting on dietaries deficient in calcium and were therefore undernourished in this respect." It has been shown that there is a daily exchange of 0.88 gram of phosphorus and 0.45 gram of calcium in the adult of average weight; therefore it is necessary that the diet contain at least that amount of each in order to maintain a normal chemical balance as pertains to these minerals. Recent investigators stress the importance of ample calcium and phosphorus intake, especially in the individual who is suffering from bone disease or parathyroid dyscrasia.

In summary in regard to mild states of malnutrition, it is well expressed by Minot:

> The borderline states of nutritional insufficiency need better recognition, as does the fact that apparently satisfactory nutrition does not mean optimal nutrition. Chronic departure from the optimal diet, even if slight, can produce ill health when operative over a long period of time and especially if combined with digestive disorders or other adverse factors.

When considering the grossly inadequate diet McCarrison states:

> I claim for this experiment that it proves conclusively that one sided diets which are disproportionately rich in cereals and poor in animal fats, milk, and fresh vegetables are capable of inducing in albino rats a large proportion of the diseases included in our calendar of human ailments: I may add that of all faulty diets I have used, that composed of white bread, margarine, tea, sugar, jam, preserved meat, and scanty overcooked vegetables —a diet in common use by many people in this country—proved to be one of the worst and most likely to be associated in rats with many of the morbid states I have mentioned, especially diseases of the respiratory and gastro-intestinal tracts.

The common and characteristic manifestation of malnutrition or starvation is loss of weight and strength, and it has been demonstrated both upon the experimental animal and the human that states produced by rather prolonged periods of starvation can be corrected by an adequate diet provided the period of starvation has not been too long. Moreover, the manifestations of starvation are less pronounced and are delayed if water balance is maintained.

In the pathological patient who is a candidate for some surgical procedure, added factors become operative. Among these are: inadequate water intake and often excessive loss of water, fever which calls for an increase of energy producing elements, toxemia which affects essential parenchymatous organs, especially the liver, heart, kidneys, and the ductless glands, impairment of the hematopoietic tissues leading to anemia, interference with digestion and absorption, especially in those cases in which the gastro-intestinal tract is the seat of disease and, no doubt, other undetermined factors. These additional elements remove the individual from the category of simple malnutrition or starvation and place upon him burdens which may contribute to serious complications.

The mechanism or organs responsible for making fixed body tissues available for necessary energy are not known. It is entirely possible that, due to changes in certain organs, the mechanism may be interfered with sufficiently to deprive the individual of absolutely necessary energy producing material and thus precipitate a fatal issue. Many side issues are involved in this complicated process of nutrition during a state of malnutrition and starvation in the pathological patient. It is believed that certain amino acids are necessary in the production of hormones; as an example, tyrocine in the formation of thyroxin and cystine for insulin; therefore, in case of a protein deficiency an insufficient amount of the essential amino acids may contribute to a general hormone deficiency as exemplified by the great weakness and exhaustion with low blood pressure and subnormal temperature indicative of thyroid and adrenal insufficiency. It has also been shown that a low protein diet leads to a decrease in gastro-intestinal secretion and motility, in fact with absence of protein intake gastric motility can be completely inhibited.

The pathological process itself may seriously interfere with nutrition. Reference may be made to an obstruction at the ampulla of Vater leading to biliary and pancreatic stasis. The absence of pancreatic enzymes in the intestine prevents digestion of the limited amounts of food ingested. With stasis, changes take place in the liver which may prevent glycogen storage even if sugar be made available in the form of intravenously administered glucose. Moreover changes in the pancreas may further contribute to the general breakdown.

When the pathological, starved patient is submitted to a surgical procedure, immediately there are introduced more factors. The loss of water by perspiration, loss of blood incident to the operation, trauma in variable amounts to sundry tissues or organs, varying degrees of shock which further depresses vital functions and lowers the already low blood pressure, the spread of existing localized infection and the liberation of tissue juices or toxic substances due to lysis of tissue cells incident to hemorrhage and trauma. During this postoperative period, the patient is totally deprived of all food with the possible exception, at times, of glucose which may be administered intravenously, and the water intake may be inadequate. It requires little imagination to visualize possibilities. So frequently we hear the expression, "The patient was too weak and could not withstand the operation." How true the statement and how little was done to prevent the catastrophe. Every surgeon has observed a state of utter exhaustion, lethargy, at times disorientation, nausea with vomiting, abdominal distress, a sallow skin and dry tongue shortly after operation, there being no evident explanation for the condition. The attendant nurse expresses recognition of the condition so frequently and so aptly by: "The patient looks sick." I am convinced that in many instances it is the result of starvation in the individual upon whom another burden has been placed. At the time of this writing such an observation was made by me.

A man of 70 had a carcinoma of the sigmoid and a complete obstruction of a number of days' duration. The only assistance he had received from his attending physician was the introduction of a liberal amount of barium by mouth, 11 days previously, the barium being well distributed but retained in the colon. Several days after a colostomy the patient was found lethargic, mumbling, his skin dry in spite of the administration of liberal amounts of salt and glucose solutions intravenously and subcutaneously, the blood pressure was low, he complained of anorexia, nausea, and great exhaustion. His skin appeared sallow and there was evidence that he was in a critical condition. He was given, after much urging, two eggs, milk, and diluted orange juice. Within 12 hours his condition was radically changed. His skin was pink, he conversed without effort and handled himself easily in bed.

Such observations, I am convinced, can be made frequently.

CLASSIFICATION

The underlying factors which contribute to causes of malnutrition or subtotal starvation are varied and in many instances are overlooked by the physician. I should like to present a classification to cover the majority of instances:

1. *The economic status.* Many individuals try to subsist, because of the expense, upon inadequate diets which are seriously lacking in animal fats and proteins and high in carbohydrates. So frequently the following dietary history is obtained: For breakfast some toast and a cup of coffee; a typical "soda counter" luncheon consisting of sweet rolls, perhaps a lettuce sandwich, and another cup of coffee; for dinner some overcooked vegetables, perhaps a little meat also overcooked, a salad, a sweet dessert, and coffee or tea. This is the diet which produced the characteristic changes in the rat described by McCarrison, and which he firmly condemns. Because of the cost, the vegetables used are the low food value type, such as carrots, cabbage, and the like, and also because of the cost, cereals are used in excess and the meats consumed are low both in quality and quantity.

2. *The voluntary diet.* Since the slender figure is so much desired, many women deliberately starve themselves in order to attain and maintain it. Their diets are wholly inadequate and when investigated reveal some startling facts. For instance a cup of black coffee for breakfast; lettuce salad or sandwich and tea for luncheon; a salad consisting of

lettuce, cucumber, radishes, possibly a small quantity of lean meat and more coffee for dinner. The wonder is that more instances of a serious nature do not manifest themselves.

In cases of obesity which are not under adequate medical control equally illogical diets are often indulged in. There is a great reduction of the intake of food including proteins as well as carbohydrates with the result that protein deficiency manifests itself. These patients lose weight but complain of great weakness and inability to carry on their usual activity. They may develop an edema, and albumin is commonly found in the urine. Such, unfortunately, is the status of some patients with gall-bladder disease who have dieted themselves upon the instructions of the physician to lose weight before operation. The patient with an albuminuria frequently has the protein intake markedly restricted as a preparation for a surgical operation and presents himself in a state of extensive protein deficiency.

The dyspeptic individual and the one suffering from some allergic disease frequently subject themselves to "elimination diets." By constantly eliminating food elements in an effort to find that specific one or group that may be producing the unfavorable reaction, the diet has become so restricted that forms of malnutrition and avitaminosis develop and are not recognized, being often masked by a screen of some obscure organic disease. In the dyspeptic patient it is important to recognize this condition because of the frequency of the need for surgical interference.

3. Loss of appetite due to chronic diseases. Those individuals suffering from some form of chronic infection often have no desire for food, moreover their appetites are perverted in that they crave those foods which are entirely insufficient. Their protein intake is inadequate and they utterly refuse those essentials of the dietary which their condition demands. They refuse eggs, milk, butter, and fresh vegetables. Orange juice "upsets their stomach." Their diet is essentially a carbohydrate one. The less they take the more they voluntarily restrict their diets and I am convinced that much of the loss of weight, weakness, and the inability to combat infection is due to malnutrition and unrecognized states of avitaminosis. Mental states play an important rôle in loss of appetite. Worry over the nature or outcome of their illness and concern of economic or family affairs are to be considered.

Loss of appetite is a common symptom in malignancies and may appear early in the course of the disease. I believe that in a considerable number of cases, starvation is as great a factor in the loss of weight and strength early in the process as the presence of the malignant disease. With obstruction such as may obtain in carcinoma of the esophagus, cardia, or pylorus, the nutritional status becomes a factor of paramount importance. It has been my experience that those patients who can be adequately nourished have less distressing symptoms, lose less weight and strength, and live considerably longer.

4. Conditions associated with pernicious vomiting. This group needs little amplification. However it should be brought to our attention that some individuals may eat what appears to be an adequate intake yet because of its nature the food value is insufficient in quality as well as in quantity, and a false sense of security may be established. It may also be said that, due to persistent vomiting, there is not only an insufficient intake but a real loss of essential substances which further contributes to the patient's decline.

5. Peptic ulcer. Due to the prolonged restriction in diet during the average medical management of peptic ulcer, deficiency states are prone to develop. Davidson cites 3 cases with digestive disorders which, during the course of "ulcer diets," manifested deficiency symptoms as evidenced by dental caries, bleeding, spongy gums, purpura, and intramuscular hematomas. He states:

> In such conditions as peptic ulcer in which the etiology is obscure and every effort must be made to improve the general metabolism, it is likely that a superimposed deficiency disease would be extremely detrimental. Indeed, peptic ulcer itself may possibly be looked on as an example of tissue destruction, like scurvy secondary to vitamin deficiency.

Even though some may not agree with Davidson that peptic ulcer is a deficiency disease, we cannot but agree with him that starvation and states of avitaminosis are not conducive to recovery from peptic ulcer. In those instances of peptic ulcer associated with persistent vomiting, the state of malnutrition will make itself manifest in a relatively short period of time and becomes a vital factor in the recovery of the patient. It is of this group of cases and their management that I will speak later.

6. Metabolic diseases. Under any condition in which the metabolic rate is increased, more energy producing foods must be made available. This is clearly demonstrated in hyperthyroidism. Unless the diet of the toxic thyroid patient is adequate, there will be a marked loss in weight and strength. Here, again, it must be stated that carbohydrates are essential but proteins must not be excluded as an adequate protein intake is necessary. There is an old adage, "Starve a fever and feed a cold." It is interesting to note that even today some medical men still cling to this axiom, this despite the marked revolution which began about 1906 when typhoid fever patients were first fed liberal diets. It is the consensus today that fever cases demand sufficient food to sustain them and not to allow the body tissues to be metabolized.

7. Conditions in which there is an inability to utilize ingested foods. This condition has been alluded to earlier in this paper in citing the incidence of obstruction of the pancreatic and common bile ducts so that the digestive enzymes are prevented from entering the intestinal tract. Under such conditions, there may be an ample intake of food, but because of the absence of digestion the patient will derive little benefit; there will be a rapid loss in weight and strength and a typical clinical picture of starvation will ensue. Mackie and Henriques studied 75 consecutive cases of ulcerative colitis from a nutritional standpoint and report deficiency states as manifested in changes in the mucous membranes of the tongue in 46 cases, abnormal buccal mucosa in 4, abnormal skin conditions in 11, anemia in 39, peripheral neuritis in 1, blood chemistry changes in 7, and 3 with inversion of the albumin-globulin ratio and extensive edema. No doubt those cases of achlorhydria associated with diarrhea will sooner or later develop deficiency states.

8. Mental disease. Many of the psychoses are associated with varying states of malnutrition due to the marked curtailment of the food intake. In dementia præcox states of advanced starvation are frequently found because the individual either will not eat or vomits ingested foods.

9. Alcoholics and drug addicts often present forms of malnutrition which should be recognized.

This subject of malnutrition and avitaminosis is of major importance to the surgeon, first, because of the possibility of errors in diagnosis and, second, because of the influence it has upon the outcome of the surgical procedure.

I have alluded to the clinical manifestations of protein starvation. Such states, I am convinced, may lead to a fatal termination if not recognized and corrected. Gastro-intestinal symptoms, such as excessive vomiting, loss of appetite, nausea, abdominal distress, variations in gastro-intestinal tonus, diarrhea and the like in many cases are symptoms of malnutrition or avitaminosis. Infection of the respiratory tract, one of the grave postoperative complications, in quite a few instances, has its origin in faulty nutrition. There seems little question but that wound infection, trophic ulcers, such as bed sores, secondary urinary infections and forms of stomatitis, in many instances, may be accounted for on the basis of malnutrition. Vascular changes have been observed in cases of faulty nutrition to the degree that postoperative pulmonary embolism may suspiciously be concerned. The ability of the body to repair may be impaired during malnutrition. It has been my experience that in practically every case of evisceration that I have encountered, the patient was undernourished; moreover, of those cases in which wound repair has been delayed and wound infection present, many were in a state of malnutrition.

By correlating the results of observations made upon experimental animals and proved

cases of malnutrition and avitaminosis, and many postoperative complications, I am convinced that there will be revealed a similarity worthy of notice.

DIETARY REGIMEN

I shall not attempt to describe the dietary regimen of the surgical patient. The duty of the surgeon is to recognize and evaluate the state of faulty nutrition if present so that it may be corrected. However a number of specific conditions make it necessary that the surgeon institute special means to nourish the patient. Among these may be mentioned: (1) extensive ulcerations of the stomach; (2) carcinoma of the stomach; (3) carcinoma of the esophagus; (4) duodenal or gastric ulcer with acute exacerbation associated with excessive vomiting and marked nutritional disturbances; (5) gastrojejunal ulcer; (6) post-gastro-enterostomy persistent vomiting; (7) after gastric resection in the under nourished individual; (8) linitis plastica; (9) extensive trauma to the stomach; (10) extragastric or duodenal lesions associated with marked nutritional disturbance in the presence of excessive vomiting. In these cases, the ability to nourish the patient becomes a vital factor and the outcome will depend upon whether sufficient food can be administered so that life may be maintained. In such cases jejunostomy with jejunal alimentation becomes the procedure of choice.

Many attempts have been made to nourish the devitalized patient by means of jejunostomy and jejunal alimentation but in many instances the procedures have resulted in failure because the food used irritated the intestinal tract or was unsuitable from a nutritional viewpoint. It was not until Ivy and his co-workers, after extensive experimental work upon the dog, developed a pabulum which would not irritate the intestinal mucosa that successful jejunal alimentation became possible. They also suggested that the pabulum "be administered slowly simulating the manner of emptying of the stomach." The Ivy pabulum consists of: whole milk, 1,500 cubic centimeters; cream (20 per cent butter fat), 500 cubic centimeters; cane sugar, 150 grams; wheat flour, 120 grams; peptone (dried), 80 grams; water, 2,000 cubic centimeters. From 6 to 12 grams of salt, depending upon the need, is added. This amount represents about 3,340 calories and is intended for a one day feeding. The specific amounts of sugar, peptone, flour, and cream will have to be varied, depending upon the individual tolerance to carbohydrates, proteins, and fats. In addition to this feeding there is added daily a vitamin feeding consisting of orange juice, 100 cubic centimeters, 1 egg, viosterol, 3 drops, haliver oil, 5 drops, and 1 tablet of Harris' yeast. It has been shown that, with such feedings correctly administered, the experimental animal will maintain a proper nutritional state for many months. Scott and Ivy have also demonstrated upon the dog with a Pavlov pouch that adequate jejunal feeding reduces an excessive acid gastric secretion and with the addition of atropine the acid secretion may be entirely eliminated, also that with continuous feeding hunger contractions are inhibited thus putting the stomach at rest.

JEJUNOSTOMY

A left upper transrectus incision is used when the operation is done primarily for a jejunostomy. A hurried exploration may be done and a loop of the jejunum approximately 12 inches from the duodenojejunal junction is brought into the wound. A catheter is implanted by the Witzel method at the antimesenteric side of the gut, the catheter being inserted at least 8 inches into the lumen of the jejunum. We have used ordinary soft rubber catheters ranging in size from 20 to 24 (French). It is important that the catheter extend well down into the lumen of the gut so that the pabulum is introduced into the gut away from the site of opening, thus reducing the possibility of leakage. The catheter is fixed to the wall of the jejunum by two catgut sutures at the site of the jejunal opening, and is then drawn through an opening in the omentum and brought out of the abdomen through the lower end of the abdominal incision. The jejunum is fixed to the abdominal wall with a catgut suture to prevent separation in the event the catheter is pulled out of place. The remaining portion

of the abdominal incision is then snugly closed. In the event that the jejunostomy is done as a complementary procedure when a right rectus incision has been employed, the catheter is drawn through a stab wound through the left rectus muscle at a site convenient to the position of the loop of gut employed. If care is taken the catheter will remain in place for a number of days. However, if it is accidentally expelled or pulled out of place, it can be introduced again quite easily. After cleansing, the catheter should be well lubricated with such an agent as KY jelly and gently inserted. No force should be used for as soon as it enters the gut the peristalsis will draw it along.

JEJUNAL FEEDING

The usual errors in jejunal feeding are the use of an irritating food and incorrect administration. The specific tolerance of each individual must be determined during the early stages of the feeding. In the majority of instances the pabulum is given too rapidly. After considerable experimentation there was built, by the Department of Physiology of Northwestern University, an electrically driven pump which will deliver any quantity of pabulum desired during a specific period of time. By a regulation of the speed and length of the piston stroke the pabulum may be given, drop by drop, or as much as 300 cubic centimeters can be given in 15 or 20 minutes. This apparatus seems to have solved the problem of the administration of the pabulum.

It is our custom to begin the administration of water almost immediately after the jejunostomy. The pump need not be used for this since the drop method will answer the purpose very well. Care should be exercised in the early administration of water since if it is given too rapidly nausea or distention will develop. This we believe is due to decreased intestinal motility incident to the operative procedure or the anesthesia. The pabulum feedings are begun from 18 to 24 hours after the jejunostomy, the pabulum being diluted 50 per cent by water. Fifty cubic centimeters of the diluted pabulum are given over a period of from 15 to 20 minutes every hour. If any symptoms develop, the feedings are given every 2 hours. As tolerance is acquired the amount of the feeding is increased so that when 100 to 150 cubic centimeters can be given during a period of 20 minutes every hour, the pabulum is no longer diluted but the amount is decreased again so as to allow the gut to accommodate itself to the nature of the pabulum. Gradually the amount of the feeding is increased until a sufficient quantity is administered to supply nutritional requirements adequately. From 3000 to 3500 calories can easily be administered without discomfort to the patient. (The vitamin feeding is not begun until the patient is able to tolerate full feedings of the standard pabulum. This usually requires from 3 to 4 days.) It has been noted that occasionally the patient will develop diarrhea or cramps. Nausea is not infrequent. The nausea is due in most instances to too rapid feeding. Cramps and diarrhea are due to the patient's inability to handle the fats or orange juice in the feedings. Occasionally, the sugar content is too high, therefore it is essential carefully to observe the individual's response to the feeding used and to modify it to avoid discomfort.

In some instances it becomes desirable to add to the pabulum other substances or drugs as may be indicated. In the presence of a pyloric obstruction with excessive vomiting or when large amounts of fluid are aspirated from the stomach, the addition daily of from 250 to 1000 cubic centimeters of the aspirated fluid to the pabulum, in divided amounts, is productive of beneficial results. We have added chondroitin in cases of liver damage, pancreatin in pancreatic disease with evidence of improper digestion of the pabulum, opium when excessive diarrhea and cramps were present, bile salts with common duct obstruction, and codeine and allied drugs for pain of any origin.

It has been a striking observation to note the improvement in the state of nutrition of the patient in a short period of time. The relief of pain due either to ulcer or carcinoma of the stomach will be prompt. The average case of carcinoma of the stomach will be completely relieved of pain within 48 hours and in ulcer cases as early as 24 hours.

The duration of the jejunal feeding regimen will depend upon the condition for which it is used. The longest time we have employed continuous jejunal feeding was in a case of extensive ulceration of the stomach in which jejunal feeding was continued for approximately 9 months.

CONCLUSIONS

I should like to make a plea to the surgeon as well as to the medical practitioner to scrutinize more closely the nutritional status of the surgical patient. The accustomed dietary of the patient should be studied in order to anticipate dietary deficiencies as well as to recognize them when present. Every patient who is to be operated upon should have a well regulated diet for some days prior to the operation if the nature of the condition will permit. During convalescence the nutritional status of the patient should be as closely observed as the surgical wound or the specific condition for which the patient was operated upon. Postoperative symptoms and complications with the nutritional status of the patient in mind, should be analyzed, especially with reference to vitamin deficiencies and protein starvation. Artificial feeding, at times, becomes imperative. This can best be accomplished by jejunostomy and jejunal feeding.

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CLINICAL SURGERY

FROM THE DEPARTMENT OF SURGERY, UNIVERSITY OF OREGON

THE RÔLE OF THORACOSCOPY IN THE DIAGNOSIS AND MANAGEMENT OF LUNG TUMORS[1]

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THE purpose of this contribution is to call attention to the value of thoracoscopy in the diagnosis of intrathoracic new-growths. No reference will be made to its use in intrapleural pneumolysis by the closed method, as I have previously detailed that subject.[2]

Thoracoscopy is undoubtedly one of the most neglected diagnostic procedures in clinical medicine. The value of bronchoscopy, cystoscopy, and ophthalmoscopy has been recognized for years, and in every worthy textbook on diagnosis will be found a discussion of their diagnostic import and interpretation of the various images disclosed. In short, the rôle of the above procedures, in their respective fields, is well known to every medical student. Thus, it seems incredible that so important a region as the pleural cavity should be excluded from study with an optical instrument similar to the cystoscope—if the paucity of contributions on the subject is any criterion. The subject has received little attention except for the value of thoracoscopy in the identification and localization of adhesions preventing a satisfactory pneumothorax in the treatment of pulmonary tuberculosis, and as a guide to their severance.

In the differential diagnosis of intrathoracic neoplasms, thoracoscopy will give information otherwise unobtainable. Moreover, in contemplated operative procedures, one may determine by this method the nature of the growth, its distribution, and the possibility of its surgical removal.

The technique of thoracoscopy consists in establishing a diagnostic pneumothorax of sufficient capacity to permit visualization of the pleural cavity, especially of the tumor mass. The uninvolved lung tissue, if there is a tumor of the lung, should be well collapsed. This can be accomplished in two or three pneumothorax treatments at 2 to 3 day intervals, controlled by the fluoroscope. After a suitable pneumothorax has been established, a set of stereoscopic films is studied to determine the location of the mass and the most appropriate site for introducing the thoracoscope.

The Unverricht thoracoscope permits the most adequate visualization; it is introduced under local anesthesia infiltration (1 per cent novocain suprarenin solution) of the particularized intercostal space. A 1 centimeter skin incision is made with the tenotomy knife, and the Unverricht valve cannula[3] and trocar are inserted into the pleural cavity. Introduction of the thoracoscope follows upon removal of the trocar, the surgical amphitheater is darkened and a complete study is made of the pneumothorax cavity. Having located the growth, a second puncture at a suitable site is made identical to the first and through this a biopsy forceps introduced through a small cannula for the purpose of securing a specimen for histopathological examination. In the interim, depending upon the contemplated operative procedure, the pneumothorax is either maintained or abandoned.

Concerning the removal of specimens for biopsy, it should be mentioned that the Unverricht biopsy forceps have proved of little value because of the difficulty of getting a "bite" of tissue, as the

[3] The author prefers the valve cannula of Unverricht for the sole purpose of thoracoscopic diagnosis: whereas, for all pneumolysis procedures, the author's "bakelite" cannula is preferable.

Fig. 1. Author's biopsy forceps.

[2] Am. Rev. Tuberc., 1929, 19: 233; Arch. Surg., 1929, 19: 1175; Graham, Singer, and Ballon. Surgical Diseases of the Chest. Philadelphia: Lea & Febiger, 1935; Cyclopedia of Medicine. Philadelphia: F. A. Davis & Co., 1935; and Goldberg, Benjamin. Clinical Tuberculosis. Philadelphia: F. A. Davis & Co., 1935.

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Fig. 2. Roentgenogram showing circumscribed area of increased density in the periphery of the left lung field, which was interpreted as probable chest wall tumor. (Reproduced through courtesy of W. B. Saunders Co.)

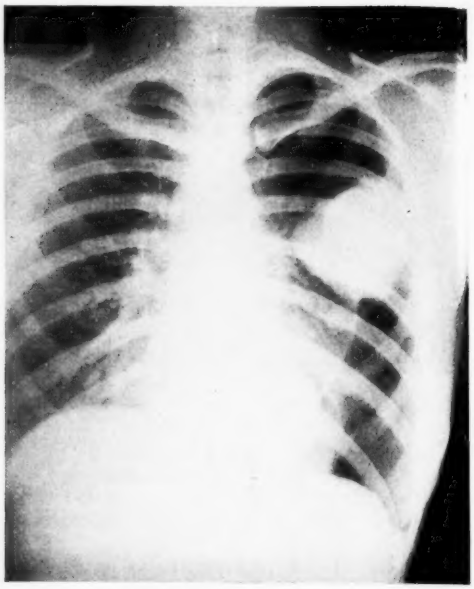

Fig. 3. Roentgenological appearance after diagnostic pneumothorax, showing lung attached to the tumor. (Reproduced through courtesy of W. B. Saunders Co.)

lung is too often forced away from the grasp of the forceps when an effort is made to close its jaws. Moreover, if the pleura is thickened, one seldom gets a section deeper than the pleura; besides, the pathologists always complain that the specimen is too diminutive to allow intimate study. Other forceps have been tried, such as those used in securing specimens by bronchoscopy, and those of the punch type—none of which have been found suitable.

In order to secure a satisfactory biopsy specimen, an especially designed forceps was devised for this purpose. These forceps are provided with jaws giving a substantial cutting surface, whereby a sufficient section of tissue can be bitten off. The jaws of the forceps are faced with a flexible rim having fine teeth. In securing a specimen, the fine teeth fix the lung as the cutting surfaces remove the specimen (Fig. 1).

While thoracoscopy is of great value in establishing a diagnosis of lung tumors, it is of particular significance in the differentiation of those primarily of the pleura with metastasis to the lung, or vice versa. This simple method enables one to determine if the tumor is primarily one of the pleura, with secondary extension to the lung—also the character and extent of the invasion can be seen and the probability of successful removal decided upon. If the lung is sufficiently collapsed, complete visualization and study of the pleural cavity can be made, provided very broad or extensive adhesions do not obscure certain areas. In any event, a definite diagnosis of the tumor type can be made before operation, either by the thoracoscopic images grossly visualized, or by the study of the biopsy specimen. In this way one becomes perfectly orientated regarding its size, position, extent of invasion, vascularity, and relationship to important structures. Valuable disclosures such as recognizing the best surgical approach and adjudging difficulties to be encountered are obtainable by no other method—consequently, the usefulness of thoracoscopy can be readily appreciated. If the tumor is adherent to the chest wall by band adhesions, or other adhesions of an operable type, they can be severed electrosurgically at the time of thoracoscopy—thus simplifying the subsequent surgical removal of the tumor.

The rôle of thoracoscopy in the diagnosis and management of intrathoracic new-growths perhaps may be best indicated by the following cases:

CASE 1. Mrs. M. H. T., aged 27 years, presented herself at the Out-Patient Clinic of the Medical Department of the University of Oregon, on October 7, 1932. Her chief com-

Fig. 4. Thoracoscopic view of intrathoracic portions of a primary osteogenic sarcoma of the rib. a, Band adhesion holding upper lobe of the lung to tumor. b, Interlobar fissure. c, Highly vascular lower lobe of the lung directly adherent to mass. (Reproduced through courtesy of W. B. Saunders Co.)

plaint was pain in the left shoulder which radiated downward and forward beneath the left breast. Her family and personal history were irrelevant. The pain was of a dull, aching character, but at times was superimposed by severe attacks. Pain was first noticed early in December, 1931. Aside from pain and a progressive weakness and loss of weight (amounting to 15 pounds since the onset of her illness) she had no complaints.

The physical examination was reported essentially negative, aside from a small, painful nodule on the seventh rib posteriorly near the rib angle. The roentgenological examination revealed slight limitation of movement of the left diaphragm. The heart was normal in size, shape, and position. The right lung field presented no aberrations. In the periphery of the left lung field was a large mass, 7 by 8 centimeters, projecting intrathoracically from the chest wall, attached apparently to the seventh rib in the midscapular line, the rib revealing some enlargement at the point of location of the mass. The lung field was otherwise clear, and no enlargement of the hilus shadow was discernible. The mediastinum was normal. Roentgenological study of all bones revealed no abnormality. The roentgenological diagnosis was "probable tumor of the chest wall" (Fig. 2).

Her blood pressure was 116/72; pulse rate 92. Blood examination revealed white blood count, 7350; polymorphonuclear neutrophils, 70 per cent; polymorphonuclear eosinophils, 1 per cent; polymorphonuclear basophils, 2 per cent; lymphocytes, 25 per cent. No pathologic cells were found. The red blood count was 3,790,000; hemoglobin 77 per cent. The Wassermann reaction proved to be negative. There was no sputum obtainable for examination. Examination of specimen of urine proved to be negative.

Fig. 5. Thoracoscopic view showing electrocoagulation of the lung attachment to tumor as a preliminary to the removal of the mass (24 days later). This method was employed to lessen bleeding and danger of metastasis to the lung. (Reproduced through courtesy of W. B. Saunders Co.)

On October 15, 1932, a diagnostic pneumothorax was made for purposes of thoracoscopic study of the tumor and to obtain a specimen for biopsy. Roentgenological study, after the pneumothorax was fully established, revealed a mass the size of a very large orange attached to the seventh rib posteriorly; also, the lung was adherent to the mass (Fig. 3). The mediastinum was mobile.

On October 17, 1932, after a refill of gas in the pneumothorax cavity, a thoracoscope was introduced through a chest wall puncture in the ninth intercostal space, posterior axillary line, under local anesthesia infiltration. The thoracoscopic examination revealed a highly vascular, globular mass, constricted in the middle, arising from the seventh rib, but adherent to the sixth and eighth ribs and intervening intercostal spaces with dense pleuritic adhesions. Both lobes of the lung were adherent to the tumor, the upper lobe being attached by a band adhesion, in which no invasion of the tumor could be observed. The lower lobe had a highly vascular attachment to the tumor and showed evidence of beginning invasion from the tumor mass to the lung (Fig. 4). The mediastinum was seen to be mobile. The pleural cavity was otherwise normal. Several sections were taken for biopsy by means of biopsy forceps introduced through another chest wall puncture under local anesthesia.

The thoracoscopic diagnosis was osteogenic sarcoma. The biopsy report was malignant tumor, probably osteogenic sarcoma.

Because of the mobile mediastinum, and the danger of flutter during the open operation, we decided to stiffen the mediastinum by inciting a circumscribed pleuritis of the mediastinal pleura at the weak point of Nitsch. This was accomplished by injecting 2 cubic centimeters of 2½ per cent oil of gomenol in paraffin oil through the second intercostal space near the sternal border, the patient resting on the table with pneumothorax side up. After ½ hour the gomenol solution was washed out with normal saline. Following this a slight serofibrinous exudate occurred, with subsequent fixation of the mediastinum.

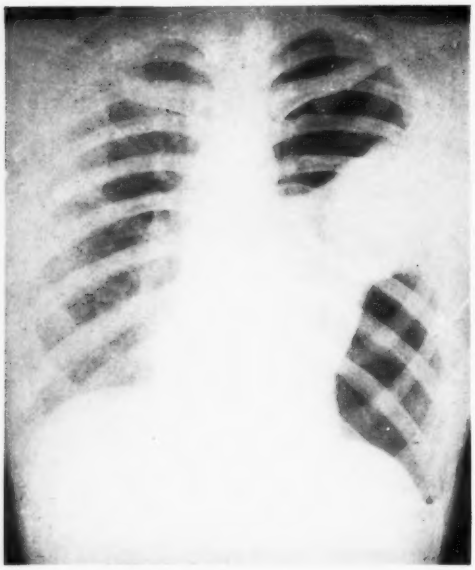

Fig. 6. Roentgenological appearance of tumor and attached lung after electrocoagulation of adhesions between the tumor and the lung. (Reproduced through courtesy of W. B. Saunders Co.)

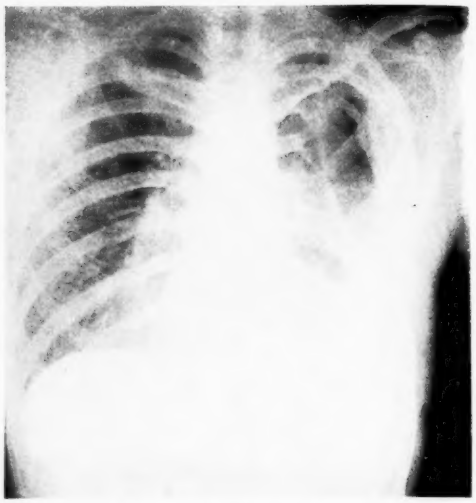

Fig. 7. Over 1 year after operation, showing entire absence of recurrence of mass on the side operated upon, with fully expanded lung. (Reproduced through courtesy of W. B. Saunders Co.)

To simplify the major operation, an intrapleural pneumolysis seemed propitious for severing the lung from the mass. This operation was attempted on November 8, 1932, after the mediastinum had become fixed. However, thoracoscopic study at this time revealed marked increase in the vascularity of both adhesions (which had now become fused together) between the lung and the tumor, rendering severance inadvisable. But the entire space between the tumor and the lung attachments was thoroughly electrocoagulated and the vascular channels obliterated (Figs. 5 and 6). On November 22, 1932, removal of the tumor was accomplished by a technique previously described in the author's article "Removal of a Tumor of the Bony Chest Wall (of Intrathoracic Origin)."[1] (Fig. 7.)

Pathological report. Gross. The specimen consisted of a portion of chest wall measuring 8 by 6 centimeters, on the internal surface of which was attached a large tumor mass. The dimensions of the latter were 10 by 6.5 by 6 centimeters. The portion of the chest wall comprised a section of the seventh rib, 8 centimeters in length and part of the periosteal covering of the sixth and eighth ribs. Its external surfaces were composed of tags of intercostal muscle. The tumor itself showed a slight constriction near its midpoint, roughly dividing it into two large globular masses, each of which in turn showed many nodules from 1 to 4 centimeters in diameter with a thick, opaque, yellowish to purplish-gray capsule which was predominantly smooth, but in some places showed small fibrous tags. At either pole of the tumor were small portions of pulmonary tissue adherent to it, having been cut by cautery. The portion of the tumor attached to the chest wall had an elastic firmness. The free globular portion appeared, on palpation, to be a large cyst with localized thickenings of the wall. The tumor was sectioned through the seventh rib. The tumor with the periosteum was separated for a short distance from the rib, leaving a somewhat pedunculated base measuring 4.3 centimeters where the cortex of the bone, periosteum, and tumor were indistinguishable, indicating that the tumor arose from the periosteum at this site. At this place there was also an increased deposit of bone in the medullary cavity of the rib. At the point of origin of the tumor it was 3 to 5 centimeters thick. The tumor was surrounded by a capsule, 1 to 3 millimeters thick, of dense grayish-white connective tissue with a slightly laminated appearance. The parenchyma consisted of very soft whitish areas resembling softened cerebral white matter. These areas were separated by soft tissue of a reddish-gray color, apparently infiltrated with blood. A small area near the point of attachment of the ribs showed some apparently undegenerated tumor tissue which is cartilaginous in consistency and dotted with yellowish to pinkish pin-point areas.

Microscopic. Several microsections of the tumor, taken from the more rapidly growing portion, showed the neoplastic cells arranged in masses separated by a small amount of connective tissue trabeculæ, areas of hemorrhage, and necrotic tissue. The tumor cell masses were composed of cells with large nuclei of rather irregular staining qualities, many of them showing mitotic figures. The cytoplasm was scanty. The cells were somewhat pleomorphic, being quadrilateral, triangular, and elongated. There were numerous small vessels with thin walls. The cells, in places, were arranged in a periepitheliomatous arrangement. In some places a fine reticulum could be distinguished. The cells were scattered in this reticulum in a manner suggesting a sarcoma. An occasional tumor cell was seen in two or three nuclei.

Pathologic diagnosis. Osteogenic sarcoma with probable origin from the periosteum of the seventh rib.

[1] Surg. Clin. N. America, December, 1934.

This case is presented to illustrate the importance of thoracoscopy in diagnosing diseases of the lung and pleura, and particularly to call attention to its value in establishing a diagnosis of tumor of the chest wall, with intrathoracic extension, or of tumors of intrathoracic origin. The procedure is simple and harmless. In this case it was possible to make a definite diagnosis of the tumor type before operation, and to ascertain definitely its size, position, vascularity, and relationship to the lung. Had the lung been adherent to the tumor by band adhesions only, they could have been quite easily severed electrosurgically, under thoracoscopic guidance, thus simplifying the major operation. This being impossible, the tissue between the lung and tumor was thoroughly electrocoagulated, so obliterating large vascular channels and diminishing the formidability of the major operation to a marked extent. Thoracoscopic examination also revealed that the mediastinum was labile. Obviously, upon opening the chest wall the danger of flutter was imminent, but by the procedure outlined, rigidity of the mediastinum was established and at no time when the chest wall was open was there any evidence of mediastinal movement; hence, the patient was rendered a much better surgical risk. The preoperative pneumothorax too presented a distinct advantage, because the danger of shock by the sudden collapse of the lung during the open operation was avoided. Furthermore, by this means, we determined beforehand that the lung was adherent to the tumor, and the operation was planned accordingly.

I feel certain that the preliminary procedures contributed materially to the simplicity of the major operation. Through correspondence with many thoracic surgeons, I have been informed that this is probably the first case of chest wall tumor where the diagnosis was made by thoracoscopy. The preliminary operative procedures are likewise unusual, but advantageous.

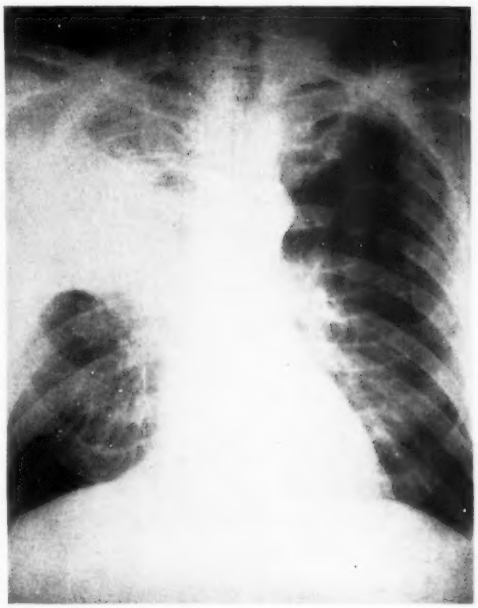

Fig. 8. Roentgenogram of Case 2, showing a suspected bronchogenic carcinoma of right lung.

CASE 2. L. R., age 60 years. Seen December 28, 1933, through the courtesy of Dr. Frank L. McCauley, internist in the Dr. Robert C. Coffey Clinic and Hospital. The patient was a farmer, male; family and past medical history of no importance. The chief complaint was shortness of breath, heaviness through the chest, bloody sputum at times, which began 3 months prior to admission on November 3, 1933. He complained of a burning sensation in the throat; perspired freely while working; had no night sweats; his appetite was poor. He had been losing weight steadily. His average weight was 195 pounds—present weight 184 pounds.

The physical examination revealed a large frame, of medium nutrition, coarse skin. Chest was large and of the emphysematous type. There was an impairment of percussion resonance over the upper half of the right hemithorax anteriorly and to the fourth dorsal spine posteriorly. Below this area, the percussion note was somewhat hyperresonant. Over the impaired area could be heard distant crackles with increased whispered fremitus with bronchovesicular breathing. The remaining portion of the right lung presented typical findings of a compensatory emphysema. Examination of the left lung field disclosed no abnormal findings. The heart was normal.

Roentgenological examination revealed a dense mass occupying the upper lobe of the right lung (Fig. 8).

The impression from physical and roentgenological examination and history of the case was "probable tumor of the right lung." Bronchoscopic examination was undertaken. The bronchoscope passed easily into the trachea to its bifurcation. No obstruction was encountered in the first or second bifurcation, although at the second bifurcation of the right bronchus it apparently lost its rotundity and had a split-like appearance. The bronchoscopic findings were otherwise negative. No abnormal tissue was seen to justify removal of a section for biopsy.

A diagnostic pneumothorax (Fig. 9) was established and a thoracoscope introduced in the midaxillary line, after the apparently uninvolved lung tissue had been collapsed. The thoracoscopic examination revealed a mass involving the entire upper lobe of the lung, which presented the characteristic gross appearance of carcinoma (Fig. 10). One could also see enlarged tracheobronchial glands.

The thoracoscopic examination was made, first, for the purpose of confirming the diagnosis, and second, for determining the possibility of excision of the growth. That is to say, if the growth were found circumscribed to the upper lobe, or with extension into the lower lobe without extensive involvement of the tracheobronchial glands, a

Fig. 9. Diagnostic pneumothorax in Case 2, revealing outline of tumor of right lung.

Fig. 10. Thoracoscopic appearance of a bronchogenic carcinoma involving upper lobe of right lung, showing almost complete involvement of the upper lobe with band adhesions between lung and chest wall.

lobectomy, if confined to one lobe, or even a pneumonectomy, if more extensive, would have been considered, provided no invasion of the tracheobronchial glands had taken place.

A section for biopsy was removed through another puncture with the Unverricht forceps. However, the pathologist reported the specimen of insufficient size to justify a diagnosis. Nevertheless, the thoracoscopic examination revealed grossly a typical carcinoma of the lung and that the invasion was much too extensive to permit surgical removal. A few days later, through a flap operation, three 12½ milligram radium needles were placed directly into the tumor mass and 100 milligrams in 2 capsules were placed between the parietal and visceral pleura over the tumor area. The radium was removed after 25 hours. However, death took place January 25, 1934. The autopsy record by Dr. Jon V. Straumfjord, pathologist at the Dr. Robert C. Coffey Clinic and Hospital, is as follows:

"This was the body of a white male, 60 years of age. An operative wound was present in the posterior aspect of the right hemithorax, 2 inches lateral to the spinous processes at the level of the sixth and seventh ribs. A segment of the ribs had been removed.

"When the thorax was opened, the right pleural cavity was found to contain fibrinous adhesions. The middle and lower lobes were collapsed and the pleural cavity contained about 300 cubic centimeters of sanguineous fluid with fibrinous flakes. The upper lobe was almost entirely occupied by a tumor mass, firm in consistency, measuring about 13 centimeters in vertical extent and about 10 centimeters in transverse diameter. This tumor was densely adherent to the parietal pleura. Several puncture marks and several hemorrhagic areas were present in the posterior portion of the middle lobe, apparently sites of introduction of radium. The tumor mass was located above this area. A small portion of the tumor immediately adjacent and above the interlobar fissure between the middle and upper lobe was necrotic. The tumor was whitish in appearance and exuded a gelatinous substance on section. The mediastinum was pushed over to the left. The bifurcation glands showed carcinomatous invasion.

"The heart presented no gross abnormalities. The left pleural cavity contained a slight excess of fluid. The left lung contained areas of hypostatic pneumonia. No tumor masses were seen.

"The abdominal and pelvic organs were essentially negative.

"The skull was not opened.

"*Histology.* The tumor mass in the right lung was a bronchogenic carcinoma with colloid degeneration. Tumor masses in the mediastinal glands were present which had the same histological appearance as the tumor of the lung. No important pathological changes were seen in the other tissues.

"*Anatomic diagnosis:* (1) Adenocarcinoma of right upper lobe with metastasis to the mediastinal glands; (2) fibrinous pleuritis, right; (3) old right pleural adhesions; (4) hypostatic pneumonia, left; (5) thoracotomy wound, right hemithorax."

In the foregoing case, the exact diagnosis of the actual character of the tumor was somewhat dubious by other available procedures, but the final diagnosis was made by thoracoscopy. Furthermore, thoracoscopy verified that the tumor was of an inoperable type.

CASE 3. J. K., male, aged 59 years. Entered the medical service, Multnomah Hospital, January 31, 1935. This man was a laborer who complained of weakness and cough of 5 months' duration. During the first 2 months of his

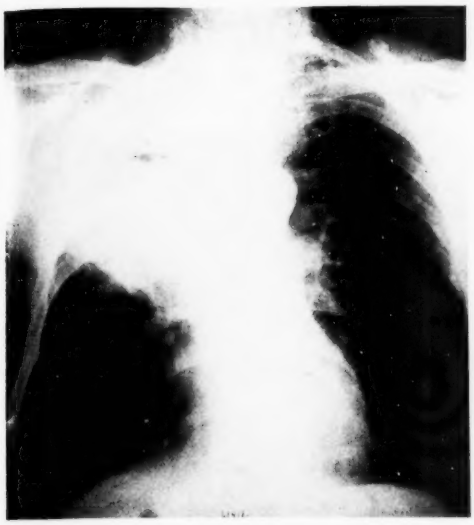

Fig. 11. Roentgenogram of Case 3 before diagnostic pneumothorax.

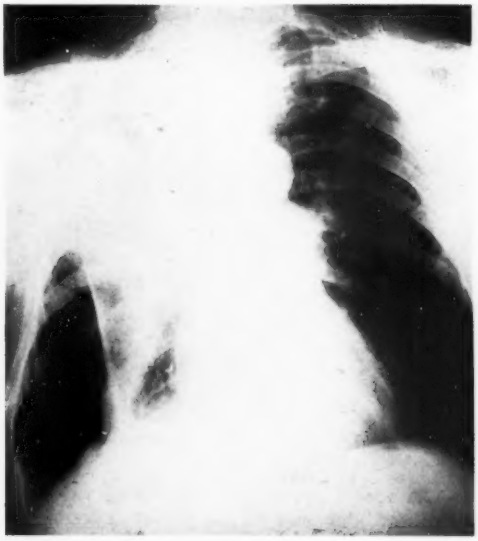

Fig. 12. Roentgenogram of Case 3 after diagnostic pneumothorax.

illness his cough was unproductive. However, during the 3 months prior to his death, he raised increasingly larger quantities of sputum (between 45 and 150 cubic centimeters daily) which, during the last 2 months, was mixed with blood. His loss of weight amounted to 20 pounds during the previous 5 months. He complained of chest pain 1 month prior to exitus.

The patient presented a pale although not cachetic appearance. Upon admission, his temperature averaged 99.2 degrees during afternoons; but it gradually assumed the septic type, and during the last 2 months, his temperature ranged between 101 and 103 degrees. His respiration on admission was 20 and pulse 100, but these both increased as his weakness became more progressive. Blood pressure was 104/64. Bacteriological examination of the sputum revealed no tubercle bacilli on repeated examinations. The blood picture was as follows: hemoglobin, 63.9 per cent; red blood cells, 3,360,000; white blood cells, 13,300; polymorphonuclears, 72; eosinophils, 1; ST, 18; mononuclears, 1; staff cells, 8. Sedimentation rate, 46/110. Kolmer reaction, 4 plus positive; Kahn, negative; urine, negative.

Admitting physician made tentative diagnosis of either fibrocaseous tuberculosis or a bronchogenic carcinoma.

The roentgenological report, on admission, follows: There is a large consolidation involving chiefly the lower portion of the upper lobe of the right lung. However, the entire upper portion of the right lung is involved. The shadow extends from the hilus to the periphery. There is a marked thickening of the pleura over this area, with possible small, multiple cavities containing fluid. Bronchogenic malignancy cannot be ruled out.

A bronchoscopy was performed. The Jackson bronchoscope was passed into the right bronchus. The mucosa appeared to be much thickened and red. A biopsy section was taken, but the section was unsatisfactory and the report stated that there was doubtful appearance of carcinoma with evidence of only a chronic inflammatory process. The case came to my service at this time (Fig. 11).

A diagnostic pneumothorax was established under local anesthesia, after which a thoracoscope was introduced in the eighth intercostal space at anterior axillary line on right side (Fig. 12). The pleural space was easily visualized. There were many bands of adhesions noted. The apical portions of the lung were adherent to the chest wall, slightly posterior to the point entered by the thoracoscope. A white, glistening protuberance was observed on the visceral pleura, adjacent to the point where the lung was adherent to the chest wall (Fig. 13). It presented the typical appearance of a carcinomatous nodule. A cannula was inserted at about the ninth intercostal space and slightly posterior to the posterior axillary line. A specimen of this nodule was removed by means of biopsy forceps; but while the thoracoscopic diagnosis was carcinoma, the pathologist reported that the section was insufficient to justify a diagnosis. Exitus occurred October 20, 1935. The following is an excerpt of the autopsy report by Professor Frank Menne, head of the Department of Pathology, University of Oregon Medical School:

"The anatomical diagnosis was massive diffuse necrotic bronchogenic carcinoma involving the right main bronchus and obstructing the lumen with resultant necrosis and suppuration. (Other anatomical findings not pertinent to the subject matter under discussion will not be given.) The right lung was bound down everywhere with fibrous adhesions formed of thick connective tissue. These tissues were swollen firmly and slightly injected. Many small pockets of creamy white material were visible on the anterior central portion of the right lung. When the right lung was removed, it was found that the parietal and visceral pleuræ separated with some difficulty. Along the posterior lateral portion, many small, fibrinous adhesions were found, with a small amount of fluid. On section, the right bronchus was occluded at its origin from the bifurca-

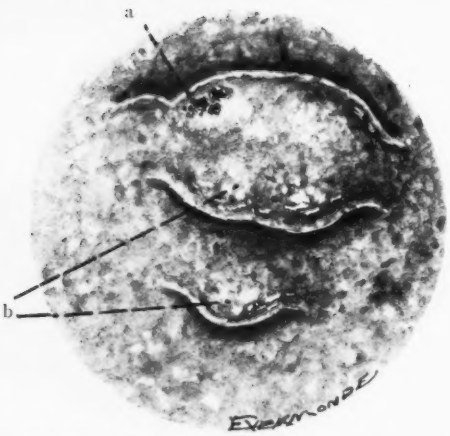

Fig. 13. Thoracoscopic view of two carcinomatous nodules on the lung parenchyma. a, Site where specimens were taken for biopsy. b, Carcinomatous nodules.

tion and periphery by a firm, white, friable material. Extending from the right bronchus was found, on cut section, a large mass of white, friable and mushy material extending out to the periphery of the lung and superior to within a short distance of the apex. Inferiorly, it extended to within a short distance of the lower and middle lobes. This mass measured 11 centimeters in diameter, and from certain portions of it, a creamy, grayish material exuded. The lower bronchioles of the right lung beyond this mass also contained considerable pinkish-gray material. Throughout the parenchyma of the two lower lobes were seen many irregular, small outlined areas, the greatest of which is 5 centimeters in diameter. The parenchyma is otherwise markedly infiltrated with coal dust and is firm and airless. The mucosa of the bronchioles is red, granulated and swollen.

"*Microscopic.* Sections from the upper lobe of the lung show a bronchogenic carcinoma. The carcinoma is of the squamous epithelioma type. Numerous forms of anaplasia are seen. Mitosis is very prominent. Giant cells are numerous, and seem to contain numerous attraction centers for the chromosomes, as many as three and four in one cell nucleus. The cytoplasm is not well outlined in places. Still other sections of lung show marked atelectatic increase in fibrous connective tissue, especially peribronchial in location. Multiple foci of polymorphonuclear and round cells are seen. In short, the section is one of pneumonia and fibrosis. The bronchioles are dilated and show bronchiectasis."

Because of the septic type of temperature and the rapid progression of disease and bad general condition of the patient, radical surgery was contra-indicated at a time when even the thoracoscopic diagnosis established the presence of a bronchogenic carcinoma. I am certain that had this case been seen earlier, it would have been ideal for total pneumonectomy.

While the number of cases that I have studied by this interesting method is small, those described are typical examples of the 14 remaining cases which have been extensively observed. And while the chief value of thoracoscopy as a means of diagnosis and guide to operative removal will concern tumors of the chest wall of intrathoracic origin as shown in Case 1, it will also provide an efficient and harmless medium for diagnosing tumors of the mediastinum and lung—provided, in the latter case, the mass has extended into the parietal pleura and is thus visible and appropriate for removal of a biopsy section.

In the case of mediastinal tumors, valuable information may be derived, as pointed out, regarding the nature of the mass, as well as its relationship to important anatomical structures and the probable difficulties of its excision. In lung carcinoma, when excision of the lobe or entire lung is contemplated, thoracoscopic examination will enlighten one previously of the extent of involvement and the possibility of successful operation, rather than subjecting the patient to an exploratory thoracotomy to determine operability—a procedure which often proves hazardous in an older person. On the other hand, thoracoscopy will reveal all the information obtainable by a major thoracotomy, and, in comparison, is neither involved nor injurious.

Since this manuscript was written, one additional case was diagnosed by the method described, after all other methods failed. A total right pneumonectomy was done, which will be described in detail in a forthcoming volume "The Treatment of Cancer and Allied Diseases," edited by Drs. George T. Pack and Edward M. Livingston (Paul B. Hoeber, Inc.). The material upon which this is based comprises cases from the combined service of the late Dr. Ray W. Matson, my associate, Dr. Marr Bisaillon, and myself.

THE SURGICAL TREATMENT OF DEEP SEATED NON-RESECTABLE ULCERS OF THE DUODENUM

A New Plastic Method of Approach

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THE surgical treatment of duodenal ulcerations by removal of three-fourths of the stomach is not based only on sound physiological principles, pathological realities, and anatomical relationships, but also upon the excellent clinical results obtained. Where the indications for surgery are definite and the magnitude and nature of the procedure commensurate with the character of the lesion, there is no more gratifying operative procedure as far as results are concerned than a properly performed stomach resection.

Since I performed the first stomach resection for duodenal ulcer in 1923, my results have been so satisfactory that a natural skepticism connected with such a seemingly extensive procedure has changed to an enthusiasm and a confidence in the rationality of this form of surgery. The immediate and remote complications which not infrequently follow the indirect surgical procedures, though well executed and by the most competent men, are rarely met with in my experience after a subtotal stomach resection by one or the other of the rational modifications of the Billroth I or II methods. Complications inherent to a gastroenterostomy have forced a skeptical attitude in the ranks of the practitioners, internists, surgeons, and the laity. The excellent results obtained in many patients subjected to a gastrojejunostomy are marred by a definite percentage of poor results where the patient fares worse than he did before his operation. The morbid conditions and disappointments which frequently follow gastrojejunostomy depend largely upon the uncertainty of anatomical relations between the stomach and jejunum. Nor are the physiological changes expected under the same control as in a stomach resection. The history of gastro-enterostomy is replete with numerous modifications and methods in order to avoid its disasters and complications. Even the standardized posterior short loop gastroenterostomy is not without criticism as to its technical perfection as witnessed by contemporary writings (Moise).

The history of stomach resection has also witnessed an attempt of many to improve and modify its technical details so as to make the operation safe and free from morbidity. It is only natural to expect that surgical procedures which change the anatomical and physiological relationships between the stomach and intestine cannot always be perfect. It will be pointed out elsewhere that the resection will give rise to an occasional jejunal ulcer or will result in dyspeptic symptoms in a few cases. The number of these is quite insignificant as compared with the original complaints and with the percentage of complete cures. The frequent argument against subtotal resection is the high mortality as compared with the various palliative procedures. This variable depends greatly on the training of the surgeon in this particular branch of surgery, and in the familiarity with the important physiological principles and anatomical relationships. Finsterer, Haberer, and several others report no greater mortality in the radical procedures than follow gastroenterostomy.

Several years ago it was my pleasure to visit a surgeon of international reputation who has adopted the subtotal stomach resection as a routine procedure and who frankly admitted that his mortality ranged from somewhere between 10 and 12 per cent. At that time I dared to advance the statement that the most frequent cause of his fatal results was pancreatitis. Upon refreshing his memory on the postmortem findings, the surgeon was forced to agree that that was the cause.

Any surgeon who attempts to remove all of the deep seated duodenal lesions penetrating into the pancreas or adhering to the common duct, or to the duodenohepatic ligament, must expect a greater mortality. It is for such deep seated ulcers that Finsterer has wisely advocated the exclusion operation combined with an extensive resection. Floercken has treated such ulcers by closing the duodenum through the ulcer area, immediately above the ulcer, or through the pyloric ring, combined with a Billroth II, with excellent results. It is hardly necessary to point out that an attempt to close the duodenum through a fragile and inflamed wall or an ulcerated area is to court disaster.

The typical exclusion operation of Finsterer has been carried out in many patients with success

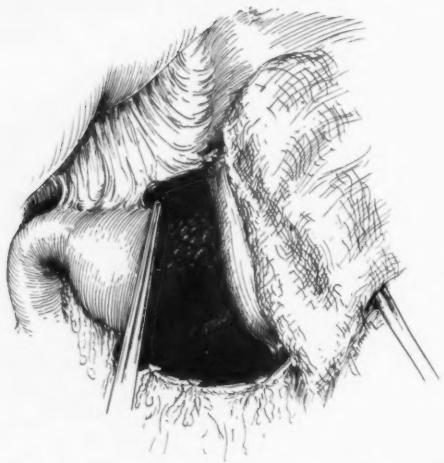

Fig. 1. Stomach has been divided and the proximal part reflected to the left.

as reported by Finsterer, Denk, Steinberg and others. Nevertheless there are certain theoretical and some practical objections to this procedure. Steinberg has definitely shown that the Devine exclusion transection without a resection produces jejunal ulcerations in a large percentage of the experimental animals. Recently Graham has reported 6 patients operated upon according to Devine, all of whom developed ulcerations soon after the original procedure. It is comforting to know that this experimental work has been not only of theoretical curiosity but of great practical importance. The clinical experience giving a hundred per cent jejunal ulcerations after the Devine procedure, is highly supportive of the theoretical speculations. One familiar with surgery of peptic ulcerations knows that the difference between the von Eiselsberg exclusion operation and the Devine procedure is only a trifle more than in the name. The Devine transection operation divides the stomach a little higher toward the cardia and terminates with a Pólya. Both produce their share of jejunal ulcers. The Finsterer exclusion operation differs greatly from the von Eiselsberg and Devine procedures in the important fact that three-fourths of the stomach is removed. Haberer, who maintains that no part of the pyloric end of the stomach, however small, should be left since it stimulates reflexly the secretion of acid from the fundus, should be won over to the Finsterer exclusion operation by considering the removal of the mucosa from the stump of the pylorus left behind. Another more valid objection brought forth against the exclusion operation is an occasional perforation or fatal hemorrhage which took place in a few cases where the ulcer was left. There is also an occasional anxiety of insecure closure of the pyloric stump left behind. Difficulties may arise where the muscle is greatly hypertrophied or where the pyloric ring engaging the duodenal ulcer in the scar forms a narrow apex on which the base of the closed pyloric stump rests. Leakage from such a stump when it is closed under tension has been reported. Some advise that more of the distal pyloric antrum be

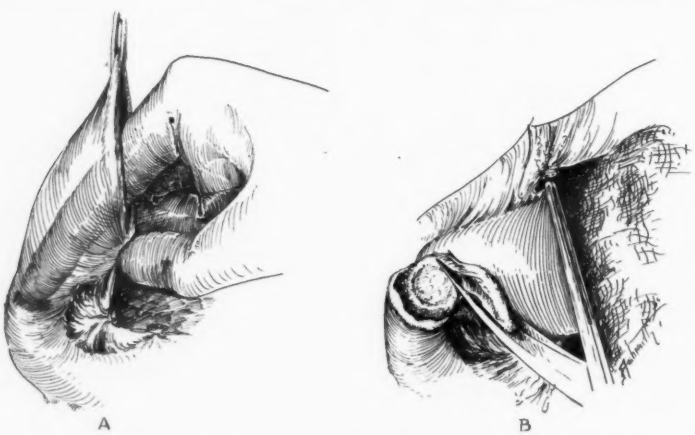

Fig. 2. A, Palpation of the duodenum through the open end of the pyloric stomach. B, Removal of the anterior part of the duodenum. A large ulcer on the posterior wall of the duodenum is seen penetrating into the head of the pancreas.

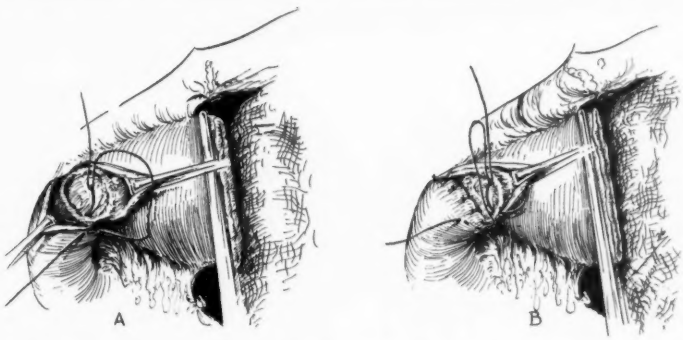

Fig. 3. A, Approximation of the anterior wall of the duodenum to the distal edge of the ulcer. B, Approximation of the anterior wall of the duodenum to the proximal edge of the ulcer.

left—a procedure which has its objections; others recommend the extraperitonization of the pyloric stump. The important objection above all is offered mainly by the acutely bleeding ulcer on the posterior wall penetrating into the pancreas. An exclusion operation offers no direct attack on the bleeding ulcer. Nissen, Bsteh, and others advocate plastic procedures which utilize the mobilized anterior wall of the duodenum to cover the ulcer on the posterior wall.

Before going into details of the technical procedures of a plastic method which has been used by myself in several cases, it is of the utmost importance to make an orientation of the criteria which point to the choice of the procedure to be carried out with safety.

According to DoRio Brancho, Yule, and recently, Plenk, the blood supply of the duodenum consists of two vascular arches, which are found on the ventral and dorsal sides of the head of the pancreas at a distance of from 1 to 3 centimeters from the duodenum. This arch is formed from the gastroduodenal and superior mesenteric and supplies both the duodenum and the pancreas. The part of the duodenum from the pyloric ring distal to where it is crossed by the gastroduodenal artery receives its blood supply from the branches of the right gastric and also the gastro-epiploic arteries. Plenk found areas of necrosis in the head of the pancreas from ligation of either the gastroduodenal or the right gastro-epiploic arteries. The dissection of the duodenum, beginning with the pylorus, should for these reasons stop at the level of the gastroduodenal artery, and furthermore, care should be exercised neither to ligate nor injure in any manner the gastroduodenal artery or the gastro-epiploic artery at its origin.

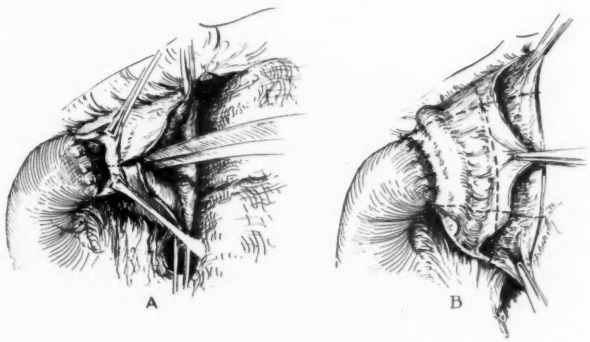

Fig. 4. A, Opening of the anterior wall of the stomach. B, The mucosa of the stomach is being removed and the dotted line shows the part of the stomach left for the plastic closure.

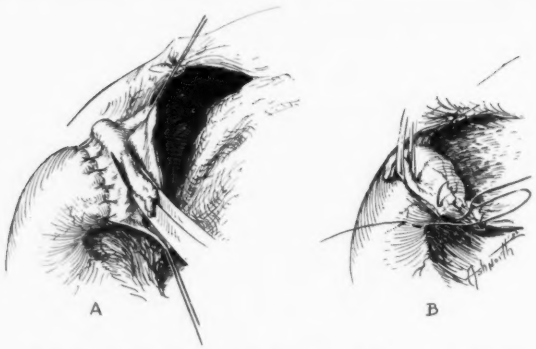

Fig. 5. A, Part of the denuded muscle of the pyloric sphincter is removed. B, The part of the stomach wall left for suture over the anterior wall of the duodenum.

Clairmont has found variations from the normal in the anatomical relationships of the pancreatic ducts in 10 per cent of cadavers. The accessory pancreatic duct may be found either occluded or serving to transmit the pancreatic juice from a single part of the pancreas or to serve as the main duct. Four centimeters was the farthest that the accessory duct has been found from the pylorus. On account of distortion from the presence of an ulcer, the accessory duct may frequently be found near the ulcer or in the ulcer crater itself. It is reasonable to believe that the accessory duct has frequently been ligated, unsuspected, and without any harm when it was obliterated. It is evident that the prevention of injury to this duct depends on the same anatomical relationships as the prevention of injury to the gastroduodenal artery. Since the accessory pancreatic duct is frequently found at the upper edge of the pancreatic head the dissection of the duodenum should not be attempted farther than this landmark. Even if one succeeds in reaching the posterior wall of the duodenum distal to the deeply penetrating ulcer into the pancreas without coming in conflict with the important structures, the posterior wall of the duodenum may be adherent to the pancreatic head so that its separation will cause a tearing of the muscle wall and make the closure of the duodenum unsafe.

The ulcers which are in a dangerous relationship with the common duct are usually large and deeply situated, either penetrating into the head of the pancreas or into an inflammatory mass in the duodenohepatic ligament. The common duct courses posterior to the duodenum and also posterior to the small branches of the right gastric artery which are ligated and divided at the superior border of the duodenum. After freeing the anterior wall of the duodenum from the gall bladder and mobilizing the lateral wall of the duodenum, one proceeds with a ligature of the small branches of the right gastric close to the duodenum. It is frequently possible, by finding the proper cleavage, safely to separate the duodenum from the inflamed mass in the duodenohepatic ligament. In cases in which it is suspected that the common duct is apt to be adherent to the ulcer it is necessary to visualize the course of the common duct. As it will be pointed out later, ulcers offering difficulties of this nature should best be handled in a manner which precludes any possibility of coming in conflict with and injuring the vital structures mentioned. In dealing with an ulcer on the posterior wall, deeply penetrating into the head of the pancreas, in which it is found that it is dangerous to free the posterior wall of the duodenum distal to the penetrating ulcer, mobilization of the anterior and lateral walls of the duodenum is of the utmost importance. Failure to recognize this will result in a closure of the duodenal stump under tension with a fatal outcome. The anterior duodenal wall is opened distal to an ulcer on the anterior wall, if such is present, or a few millimeters distal to the pylorus and through the proximal edge of the penetrating ulcer on the posterior wall. The first row of sutures includes the proximal edge of the anterior duodenal wall and the distal edge of the ulcer. The second row of sutures is taken between the anterior wall of the duodenum distal to the first and the proximal edge of the ulcer on the posterior wall. The third row of sutures is introduced between the anterior duodenal wall, distal to the second row of sutures and the pancreatic capsule which is usually thickened.

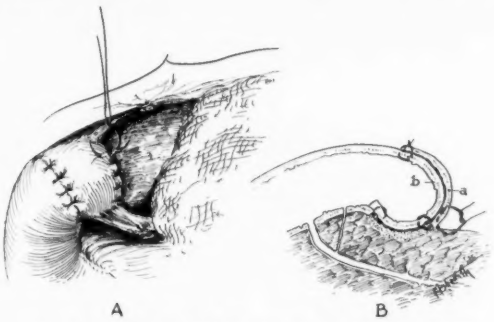

Fig. 6. A, The plastic closure of the duodenal stump completed with the stomach wall sutured to the capsule of the pancreas. B, Sagittal section of the plastic closure. *a*, Stomach wall; *b*, duodenal wall.

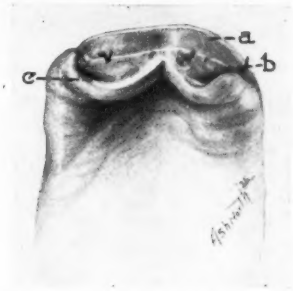

Fig. 7. Plastic closure of the duodenum experimentally produced in a dog. Specimen opened on the anterior wall. *a*, Stomach wall. *b*, Duodenal wall. *c*, Duodenal mucosa.

I have carried out this procedure successfully in 4 cases. Since in one case there was bile tinged drainage for 2 days, and in another for 10 days, it appeared to me that an improvement was needed on the plastic method of closure of the duodenum in the deeply penetrating ulcers on the posterior wall to safeguard against leakage.

For the reasons mentioned, when faced with a difficult situation, I have adopted the following method: The stomach is divided about three finger breadths above the pyloric ring and the branches of the blood vessels on the greater and lesser curvatures of the stomach are left intact. The proximal part of the stomach is protected and reflected to the left. By grasping the pyloric stump and gently putting it on the stretch, the adhesions between the gall bladder and the anterior wall of the duodenum are separated. The next step consists in the mobilization of the duodenum from the lateral side, which is very important, because one needs sufficient duodenal wall to make this plastic closure without tension. After the mobilization of the duodenum, it is necessary to manipulate it in such a manner as to assure ones self that, when inverted against the ulcer on the posterior wall, it will do so without tension. If it is found that, on account of scarring or congenital anomaly, there is not enough of the first and second part of the duodenum to cover the penetrating ulcer in the head of the pancreas, nothing has been lost, and one can proceed with the Finsterer exclusion operation. If one has the assurance that there is sufficient of the duodenal wall present the anterior wall is opened distal to the pyloric ring or distal to an ulcer on the anterior wall. The posterior wall of the duodenum is inspected and palpated to find the extent of the ulcer. The duodenum can also be palpated through the pyloric end of the stomach. If it appears that the ulcer is near the papilla, or is otherwise large or very closely adherent to the surrounding structure, the opening of the anterior wall is closed and the operation finished by the Finsterer exclusion operation. This, however, will not be necessary in many cases. In the majority of cases the method of approach will be as follows: After the anterior wall is opened the ulcer on the anterior wall is removed, the duodenum is incised on each side toward the proximal edge of the posterior ulcer, but not completely surrounding the crater. The crater of the ulcer is cauterized with phenol and alcohol. All parts of the duodenal mucosa around the crater are removed with a small curette. The first row of sutures consists of a half pursestring, taken on the greater curvature of the duodenum and the distal edge of the crater. The same is repeated on the lesser curvature. Two or three sutures are introduced between the anterior wall and the distal edge of the crater to complete the first line of closure. The second row of sutures is taken in the same manner between the anterior wall of the duodenum distal to the first row of sutures and the proximal edge of the ulcer. The next step consists in splitting the anterior wall of the pyloric stump, removing its mucosa, and suturing the seromuscularis over the duodenal closure. If there is too much of the pyloric stump left, a part of it is removed. The electric surgical knife is very useful and time saving. There is always plenty of mesentery and omentum to reinforce the closure if necessary.

Since the first row of sutures is taken between the seromuscularis of the duodenum and the distal edge of the ulcer, it gives a sure and easy enfolding of the anterior wall of the duodenum over and against the crater. It will also permit the escape of pancreatic juice or bile into the duodenum if there is any connection between

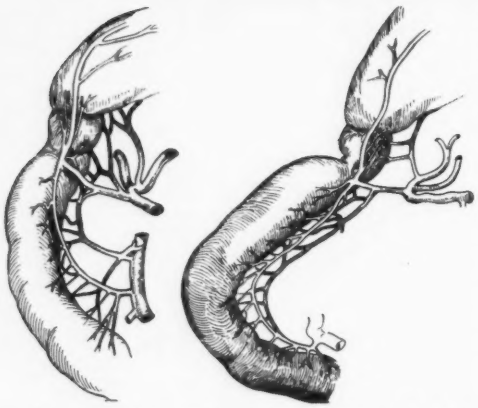

Fig. 8. The blood supply of the duodenum. (From A. Plenk. Deutsche Ztschr. f. Chir., 1932.)

these ducts and the crater. Such complications are certainly very rare. It would hardly be possible for these secretions to escape into the peritoneal cavity because the closure is not under tension and consists of several layers, and in my opinion, is more secure than even the typical closure of the duodenum in the uncomplicated cases. I have used this method successfully on three occasions and have also examined sections of the plastic closure in dogs at several periods after the operation. Such a closure absolutely precludes any injury to the common duct, pancreatic duct, pancreas, gastroduodenal artery, or the right gastro-epiploic artery at its origin. The covering of the duodenal stump by a plastic procedure, utilizing a part of the stomach wall, may also be life saving in case the blood supply of the duodenal stump has been partially disturbed by the mobilization of the lesser curvature after ligation of the branches of the right gastric artery or in case the closure takes place in a fragile duodenal wall.

In any case, in either of the Finsterer operations or the plastic procedure described, in which the judgment might have been too hasty or in which the technique is imperative in a bleeding duodenal ulcer on the posterior wall, and in which the closure does not appear altogether safe, a drain should be introduced between the closed duodenum and the stomach, and surrounded and separated from the duodenum and the stomach by omental tags. The drain should be introduced through a separate incision to the right of the original one. If drainage appears on the following days, and particularly if the patient complains of pain in the back, the drainage should be slightly moved and the patient put in a Trendelenburg position (Matyas). In this manner, even if a fistula develops, the patient will be saved. These safeguards are mentioned to emphasize the importance of meeting an emergency which, fortunately, will rarely take place if one familiarizes himself with the anatomical relationships and carefully selects a safe technical procedure.

In operating for duodenal ulcer, except in the presence of a perforation or acute hemorrhage, one cannot jeopardize the patient's life to the same degree as in the presence of malignancy. This consideration prompts one to make a definite decision as to the choice of procedure which will make the operation as safe as the indirect surgical attack on the ulcer. I am sure that there will be no lack of criticism because the method entails technique which does not at first appear simple. The important consideration, however, is the safety of the method.

CONCLUSIONS

The various methods of approach and the anatomical relationships, as related to the deep seated ulcer on the posterior wall of the duodenum, have been described.

Emphasis has been made of the importance of a thorough mobilization of the first and second parts of the duodenum particularly from the lateral side.

A new method of plastic closure of the duodenum in the difficult cases, utilizing a flap of the stomach denuded of its mucosa to reinforce the closure, has been described.

Such a procedure is safe and useful in some of the deep seated ulcers penetrating into the pancreas and particularly in the acutely bleeding ones in the same situation in which there is no other alternative but radical surgery when surgery is resorted to.

This method precludes any injury to the common duct, pancreatic ducts, pancreas, gastroduodenal artery, or the right gastro-epiploic artery at its origin.

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THE USE OF FASCIA LATA IN THE REPAIR OF HERNIA

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THE adequate repair of hernias is of paramount importance in industry, especially is this so in the heavy industries such as represented by the steel mills, railroads, and coal mines. The ordinary indirect inguinal hernia in a young adult is a condition which need cause the average surgeon very little concern.

The chance of recurrence is slight if a reasonably good repair is done and the patient is kept off work 4 to 6 weeks. There is, however, a group of hernias which owing to the type of rupture, the age or obesity of the patient, the abdominal muscular development, and the type of work to which the man must return, must be considered separately and due care and judgment must be exercised in their treatment. This comprises 20 to 25 per cent of all adult hernias which come to our attention, and they are the type with which this paper essentially deals.

Dean Lewis, by his work in filling in gaps in torn and burned tendons with transplanted fascia, showed that fascia could be used in this manner without losing its gross and histological characteristics and in 1901, Dr. McArthur of Chicago suggested that recurrent hernias be repaired by using a strip of the aponeurosis of the external oblique. To Gallie and LeMesurrier (2), belongs the credit of bringing before the profession the real value of living fascial sutures. In 1921 they published a successful technique for the employment of fascial strips taken from the fascia lata as sutures in repair of recurrent and long standing hernias. This contribution and a further contribution by the same men in 1930 (3) assisted tremendously toward the better treatment of difficult hernias.

Transplanted fascia unchanged. Through observations of the transplanted fascia of rabbits at various stages, it was shown that soon after the transplantation the surrounding blood vessels became engorged, an excess of lymph was secreted, and in 3 weeks this inflammatory process had advanced to the formation of spindle shaped cells and fibrous tissue with blood vessels which had formed across the suture line. One year later there was no change in the transplanted fascia.

INDICATIONS

Direct inguinal hernias. The percentage of recurrence in direct inguinal hernias is high. Erdman reports 16.1 per cent; Massachusetts General Hospital, 15 per cent; Johns Hopkins Hospital, 29.7 per cent; and other reliable observers, up to 40 and 50 per cent recurrence within 2 years. Andrews and Bissell recently stated that it was useless to repair direct inguinal hernias because they caused but little discomfort, did not strangulate, and in many cases were worse following operation than before. This, however, has not been our experience in any respect, these patients complained considerably of pain and, by the use of fascia lata, we have been able to repair them satisfactorily. Direct inguinal hernias usually occur in adult males, 98 per cent occurring in males over 15 years of age. In older textbooks the statement is found that they represent only 5 to 10 per cent of hernias, but in our experience 25 to 30 per cent of inguinal hernias are direct in type. They are bilateral in 55 to 66 per cent of cases. We do not feel that all direct hernias need the support of fascia to make a satisfactory repair. In the small bubonocele type, it is unnecessary and in people in sedentary occupations even though the hernia is of fair size, the repair is usually permanent without the aid of fascia lata. Age, obesity, and muscular development play a part in our decision as to the type of operation needed.

Anatomy of direct inguinal hernia. The triangle through which a direct inguinal hernia occurs is that bounded below by Poupart's ligament, medially by the sheath of the rectus and above by the internal oblique and transversalis muscle. The successful closure of this area by tissues that will satisfactorily unite is the important step in the permanent repair of inguinal hernias. The floor of this triangle is formed by the transversalis fascia which is weakest in its mid part. The conjoined tendon is very frequently absent or almost completely obliterated. This then necessitates that the belly of the conjoined muscles, rather than the obliterated or weakened conjoined tendon be sutured to Poupart's ligaments, in order to effect a repair. The space which must be closed is often large, undue tension on the muscles will weaken them, and it is for this reason that to augment the repair with fascia lata is of great benefit.

Large indirect inguinal hernias. This type of rupture in a patient past middle life in a strenuous occupation needs the soundest repair possible. This is especially so if the man is obese, ab-

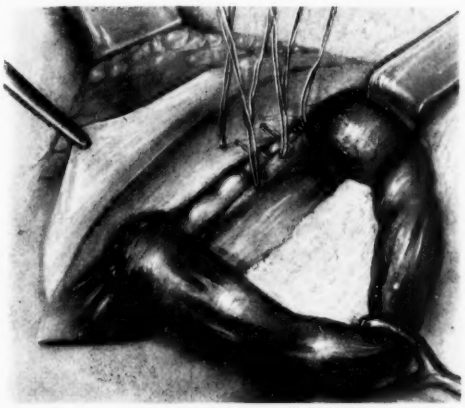

Fig. 1. Double interrupted catgut sutures (left untied) placed between conjoined tendon and the shelving edge of Poupart's ligament.

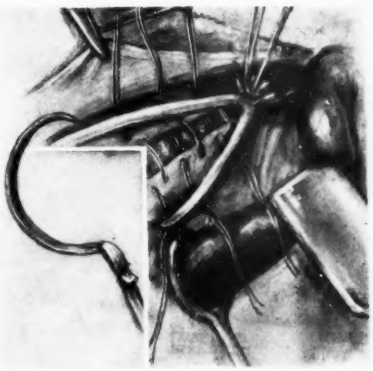

Fig. 2. Inset shows needle threaded with fascia. Fascia is being sutured at lower end of incision.

dominal musculature poor, or if he is afflicted with a complication such as chronic bronchitis. In these cases there is not only the peritoneal protrusion through the muscles of the indirect hernia, but also a weakening of the whole posterior wall.

Recurrent inguinal hernias, direct or indirect. If for some reason the sac is left in place in an indirect inguinal hernia, recurrence will take place within a few weeks of return to work. If a hernia remains repaired for 2 years and then a lump appears at the site of the original operation, I believe that we may consider it a new hernia. Those in which a sac has been removed and yet a hernia occurs within a few months, need the addition of fascia lata in their repair, because obviously the muscles of the posterior wall are too weak to stand the necessary strain. In those cases in which a new hernia develps at the site of an old one, fascia lata should certainly be used in the second operation, because there must be a congenital or acquired muscle weakness.

Ventral hernias—incisional. These do not include umbilical hernias as these are satisfactorily taken care of by a Mayo repair, but the postoperative hernias, especially following a suppurating abdominal incision usually have a wide defect and need all the reinforcement possible. The very large majority of this type of hernia can easily be brought into apposition and satisfactorily repaired by the use of the fascia lata strip. There are, however, a few extensive abdominal wounds or long standing incisional hernias in stout people that require the patch transplant as described by Gallie and LeMesurrier in 1930.

TECHNIQUE OF REPAIR OF DIRECT AND LARGE INDIRECT INGUINAL HERNIAS

It has been well demonstrated that a fascia to fascia union of the tissues is much more durable than a muscle to muscle union or a muscle to fascia union. The interposition of fat at the suture line is also detrimental to firm union, therefore, throughout the operation a conscientious effort must be made to clean the approximating tissues of all fat or damaged muscle. The usual Bassini repair is made with the cord transposed above the external oblique. Double interrupted catgut sutures are placed between the conjoined muscles, the remnants of the conjoined tendons and the shelving edge of Poupart's ligament. A loop stitch is used in order to approximate both the body and margins of the structures to be brought into apposition. The sutures placed both above and below the internal ring are left untied until the introduction of the fascia lata. While this part of the operation is going on, an assistant has procured fascia lata from the opposite thigh, a double strip 14 inches long, each arm of the strip ¾ inch wide and left united by a small square of fascia at the lower end. This is thoroughly cleaned of fat and muscle and threaded and tied with linen on Gallie needles. The double strip of fascia lata was devised by Murray and, in our experience, is more efficient than the single strip as first suggested by Gallie. The strength of the repair depends upon the amount of healthy fascia properly placed at the line of union and, with the double strip, the lower united end of fascia lata is placed in that most vulnerable position for recurrence, just above the pubic bone. The two needles enter the shelving edge of Poupart's ligament, and the conjoined muscles respectively just above the

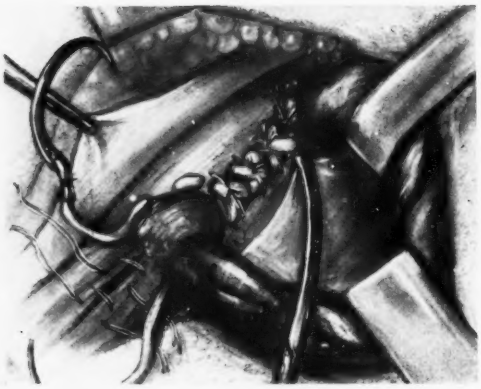

Fig. 3. Fascia laced in place.

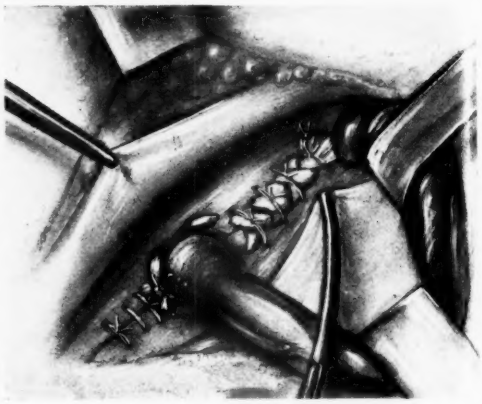

Fig. 4. Fascia suture completed around internal ring.

pubic spine and the fascia lata are used as suture material crossing over the junction of the two structures in a manner resembling the football stitch. As the fascia progresses upward the double catgut sutures are tied, holding the fascia lata in place. Tension is not taken by the fascia lata but by the catgut sutures. The fascia is threaded in and out around the internal ring and above the ring it is carried upward in the same manner as below the ring. In our series of cases we have not found it necessary to bring the fascia lata down the external oblique muscle as advised by Gallie and LeMesurrier. The usual closure is made of the external oblique muscle, subcutaneous tissues and skin. The fascia lata of the thigh is closed in every case.

In the ventral hernia a similar technique is used, the muscles are approximated, and a liberal amount of fascia is employed. In large hernias of any type, but more especially the ventral type, a patch transplant is used.

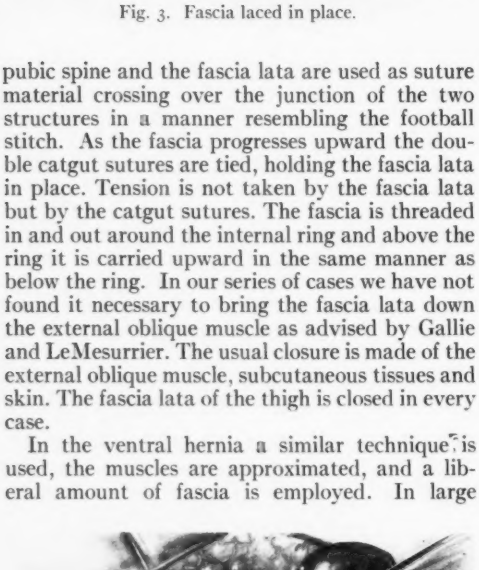

Fig. 5. External oblique sutured with cord transposed.

TECHNIQUE OF PATCH TRANSPLANT OF FASCIA LATA

When the protrusion of peritoneum is so great that it is impossible to approximate the muscles satisfactorily in any type of hernia, then the patch transplant is indicated. In the very large majority of cases the hernias necessitating this procedure are incisional hernias. In their repair, the scar tissue is excised, no attempt is made to separate the layers of the abdominal muscles, and the peritoneum is left unopened. The muscles are then undercut for ½ inch around the margins of the hernia and the whole is cleaned of fat and muscle fragments. A piece of fascia lata of required size usually about 5 by 3 inches is removed from the thigh, and no attempt is made to close the defect in the thigh.

The edges of the fascia are cut into strips ½ inch wide made sufficiently long to be brought through the thick hernia margins and overlap in the center. These tails are then tied and their knot is sutured with catgut. The subcutaneous tissues and the skin are closed over this. It is sometimes necessary to use two patches of fascia and if so these patches are sewed together with a fine ¼ inch strip of the same material. If this patch transplant is used in a large inguinal hernia, the fascial sheet should extend above the internal ring, and the cord is allowed to enter the abdomen between two tails of the fascia lata.

During the 5½ year period from January 1, 1929, to July 1, 1934, we operated upon 740 hernias at this clinic. In this group we felt it

necessary to transplant fascia lata from the thigh to supplement the hernia repair in 101 cases. This comprises 13 per cent of hernias and this percentage probably would have been larger but for the fact that many of these herniorrhaphies were in children. Our satisfaction with the the operation is shown by the fact that we are doing proportionately an increasing number of fascia transplants to prevent recurrence. Of these 101 hernias, the large direct inguinal hernias comprise 74; the large indirect type, 17; and ventral incisional hernias, 10 in number. Of all of these different types 24 patients had previously been operated upon by ourselves or someone else, and recurrence had taken place.

RESULTS AND COMPLICATIONS

Recurrences. The very large majority—about 90 per cent of these patients were employees of subsidiaries of the United States Steel Corporation and consequently a check-up by the company surgeons was easily accomplished. There were no fatalities, and all of these men had been returned to their usual employment; of the 101 cases, recurrence had taken place in only 7 by December, 1935, which is 18 months after the last herniorrhaphy accounted for in this series. When it is taken into consideration that no hernia was turned away without operation except on account of other physical defect, that many of these were in men over 60 years of age and that the men were returned to hard active labor, that descriptions of their hernias included such terms as "has recurred twice before," "has been refused operation due to size of hernia," or "totally incapacitated due to size of hernia," then we feel grateful that we have this very excellent supplement in the repair of hernia.

In more detail the recurrences were as follows:

1. Two recurrences in the same man who was operated upon for double direct hernias. Only one single strip of fascia was used on either side and it is felt that if a double strip had been used his chances of permanent repair would have been better.

2. One ventral incisional hernia which discharged some purulent material and fascia following the operation.

3. One direct inguinal hernia which did likewise.

4. A ventral hernia in the lone woman operated upon for a huge hernia which had occurred following a wide transverse abdominal incision, in whom it was necessary to do a patch transplant to effect a repair. She became pregnant and 6 months later was thrown over a trolley seat in a street car accident with immediate recurrence of the hernia.

5. One direct inguinal hernia in which there is a small recurrence just above the pubic spine, evidently due to insufficient fascia lata.

6. One large direct inguinal hernia in which there was some discharge following operation.

All of these except one have submitted to a second fascia transplant and been satisfactorily repaired.

Infection and necrosis. In 10 per cent of cases there was a seropurulent discharge from the incision sometimes accompanied by the protrusion of fascia. Three of these cases had a recurrence of the hernia.

Double testicular atrophy occurred in a recurrent double direct inguinal hernia but was probably unrelated to the introduction of the fascia lata.

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COW HORN FIXATION IN BONE SURGERY

Its Use in Forty Cases

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In 1934, Fowler[1] reported the use of cow horn as a fixation material in fractures. In Dr. Fowler's quoted bibliography, there is evidence that cow horn is a keratin substance, containing large quantities of cystein. Cystein was shown by Hammett and Reimann[2] to stimulate growth by causing increased mitosis. Cystein has been shown to stimulate granulation tissue in old chronic ulcers by Brunsting and Simonsen.[2] Dr. Fowler's 9 clinical cases with 21 others which he had collected from the literature, notably from the clinic of Lexer and Boliarsky, would seem to indicate that this material has properties which might stimulate bone repair and otherwise provide a fixation material useful in holding the position of fragments.

Impressed with these reports and in the observation of some of Dr. Fowler's personal cases, I decided to give the method a trial. I had no difficulty in finding Texas longhorn material.

Preparation. The horns are secured fresh from the packing house and with the aid of a hack saw and an emery wheel are cut and ground into various shapes. Horn nails in different sizes and lengths are found most convenient.

[1] Fowler, Edson B. Cow horn for fixation of fractures. Its stimulating effect on callous formation and a simplified technic. Illinois M. J., Sept., 1934.
[2] Quoted by Fowler, loc. cit.

Fig. 1. A, left. Compound fracture of metacarpal, 3 months after injury; 7 months following closure of sinus, no union. Cow horn nail was used for fixation. B, Union progressed, although sinus reopened. The nail was removed 60 days later; no absorption.

Sterilization. Specimens were autoclaved 30 minutes, 40 minutes, 1 hour, and 1½ hours and all were negative after 5 days' incubation. The technique we have followed for clinical use is as follows: The nails and pegs are boiled for 1 hour before sending to the surgical division. They are again autoclaved with the instruments and supplies in the routine set up for the operation. Repeated sterilization adds to the brittleness but while moist either from the recent boiling or when remaining in contact with living tissue retain their normal flexibility. After several boilings they are discarded for pressure specimens.

Tensile strength. Results of experiments show a unit strength of cow horn to be 13,000 pounds. For comparison, iron has 60,000 pounds and piano wire 80,000 pounds. Boiling does not reduce the tensile strength. Cross strain resistance increases rapidly with the size of a peg. When moist, pliability is increased and the breaking point occurs at approximately 50 degrees of bending through leverage action.

Absorption rate. We have had occasion to remove cow horn pegs and nails from clinical cases at various periods after reduction, and since the reaction is at variance with some published reports, a history of the specimens will be given in some detail.

Case 1. Fracture of the olecranon process. The fragment was held with a single horn peg. Union was good in 4 weeks, but patient complained of an uncomfortable sharp point beneath the skin which was found to be the end of the horn peg. It was left for another 30 days until union was firm. Through a small incision, the horn peg was extracted without resistance. In gross appearance the peg was just as it had been placed at operation; no evidence of absorption.

Case 2. A compound fracture of a metacarpal in malposition and non-union. Ninety days after injury, 30 days following healing of sinus the fracture was reopened and position secured by small horn rod. The wound broke down and continued to drain for 60 days, but during this time the fracture united. After removal of the horn tissue, the wound promptly healed. The horn nail remaining in a suppurative area for 60 days did not show any reduction in size or other evidence of absorption (Fig. 1).

Case 3. A fracture of the tibia 4 months after the injury in delayed union and faulty position. The bone ends were freshened, placed in good contact and held with an intramedullary peg placed through a drill hole in one fragment following the technique described by Dr. Fowler. Six months later on account of non-union, the fracture was exposed for bone graft. The cow horn was found lying in

Fig. 2. Fractured tibia, 6 months after cow horn plate and nails had been applied for fractured leg (3 weeks in malposition). Non-union—plate and nails removed for bone graft. Absorption of cow horn material approximately 25 per cent.

Fig. 3. Fractured clavicle. Open reduction with intramedullary cow horn pin fixation. Union in 6 weeks.

Fig. 4. Fractured shaft of humerus 3 months after open reduction (fracture 5 weeks old in malposition). Fixation by intramedullary peg.

Fig. 5. A, left. Fractured condyle, 4 months after injury—non-union. B, Same, 4 months after replacement of fragment and fixation with single cow horn nail. Union firm. Note epiphyseal change. Same type fixation indicated in early fractures with better prognosis.

Fig. 6. A, left. Fractured ankle, malleolus, non-union 3 months. B, Six weeks following open fixation of malleolus with cow horn nail, there was union; complete recovery.

position as it had been previously placed and was lifted out easily with a tissue forceps. The cortical surface of the bone in the drill hole, through which the peg had been placed, was smooth and glossy from a covering of connective tissue. The peg was apparently of the same size and consistency as on the day of application 6 months previously. It should be noted that this tibia in non-union might influence the adhesion of the graft to the bone through motion.

CASE 4. A fracture in the neck of the femur, 4 months after injury, in faulty position and non-union. The femoral head was viable. The hip was exposed, the fragments were freshened, and a Smith Peterson nail was used for fixation. Some additional drill holes were made for improving circulation, and through one of these a small cow horn peg was inserted. Six months later a reconstruction operation was done on the hip. The nail was very tight in the trochanter and neck and required the use of a heavy extractor for removal. The cow horn peg on the other hand was quite loose, although it had been driven in tightly at previous operation. The peg when removed was apparently slightly smaller and showed a more uniform, smooth surface than when introduced.

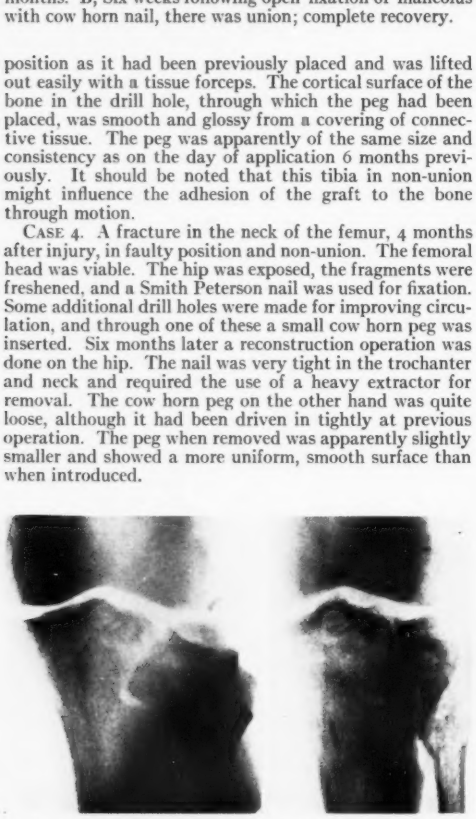

Fig. 8. A, left. Recent fracture plateau of tibia. B, Same 6 weeks following open fixation of fragment by a single cow horn nail.

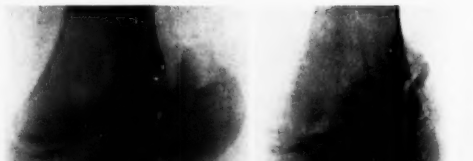

Fig. 7. A, left. Fractured condyle 6 weeks after injury. B, Same 3 months after open reduction and fixation with single cow horn nail.

CASE 5. A comminuted fracture of the tibia was fastened with a cow horn plate, held in position with four horn nails. The position remained good but subsequent roentgenograms showed absence of callus. Five months later, because of non-union, the fracture was exposed. The plate was found completely covered with connective tissue which pealed off rather easily. The nails were tight in the tibia and two of them removed showed considerable evidence of absorption. The two other nails were so tight and the horn tissue so soft that the ends were macerated in an attempt to remove them. The plate itself was definitely thinner and smoother than on the day of application. The surface of the bone on both fragments which had been in contact with the plate was smooth and covered with a fibroperiosteal layer (Fig. 2).

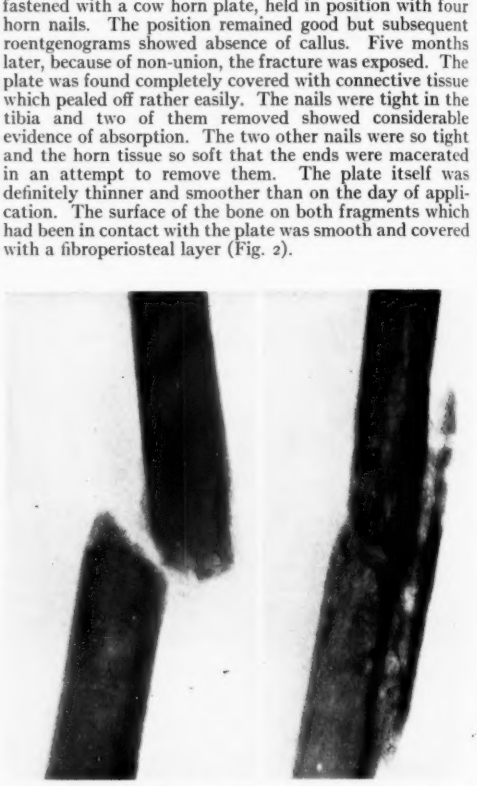

Fig. 9. A, left. Fractured humerus 4 months following injury, non-union. B, Same 5 months after onlay bone graft, fixed with cow horn nails.

The cystein content of the specimens removed after remaining 6 months in bone tissue was 13.75 or approximately 75 per cent of normal horn tissue.

These clinical observations indicate that cow horn is tolerated by bone tissue as a foreign body and is very slowly absorbed. With the slow rate of absorption and the slow release of cystein it is not believed that the material is of any definite value in stimulating bone union. However, it is well tolerated and does not appear to influence unfavorably the processes of repair.

On the assumption that it is well tolerated and slowly absorbed we have continued to use horn tissue in certain types of fractures because of its adaptability as a fixation material. Either nails, rods, plates or slabs have been used to fix fragments in more than 50 cases. The method has been applied to the clavicle, humerus, radius, and ulna and around the processes near joints. There have been 2 cases of non-union, one of them a clavicle, and the other the fractured tibia here reported. The position held in the described fractures has been fair only from the lack of firm fixation in an accurate reposition. In one forearm fracture the ulna was fixed accurately with a removable screw and the radius less perfectly with a cow horn peg, yet the radius was firmly united 2 weeks earlier than the ulna.

For fractures around joints such as the condyles and malleoli the method is most adaptable. In 3 instances a fractured internal malleolus separated and in non-union has been freshened and fastened back with a horn nail followed by rapid union. In 2 instances the head of the radius has been re-attached to the shaft by means of a small flat head, horn nail. The nail head was counter sunk beneath the cartilage and did not interfere with function. In the application of nails, the drill hole is made of the same size and length as the nail. If necessary the length of the nail can be altered by cutting the end and resharpening. A generous head is left for impacting into the bone. A nail so applied maintains tension apparently as well as a steel nail. In 10 instances we have used horn nails in conjunction with autogenous bone grafting. The autogenous graft of the onlay type is fastened with horn nails. The results have been satisfactory. One of my associates, Dr. Girard, has designed a unique horn anchor for fresh fractures in the neck of the femur. He has used it in 2 instances with rapid union.

SUMMARY

1. Horn material is adapted for many uses in bone surgery.

2. It can be formed into slabs, plates, straight or curved rods, and nails.

3. It has a high tensile strength and yet enough flexibility for easy application.

4. Specimens are sterilized by 30 minutes of boiling but 1 hour of preliminary boiling advisable.

5. When placed in bone tissue, absorption is very slow, probably 8 to 12 months. It is tolerated by the tissue as a harmless foreign body.

6. The release of cystein is so slow that it is of doubtful value in stimulating bone repair. The fracture will be united before the cystein is released or in case of delayed union any good effect which the cystein might have would probably be overbalanced by the other factors which have been the cause of the delayed union.

THE PRODUCTION OF VAGINAL ACIDITY BY ESTRIN

Its Importance in the Treatment of Gonorrheal Vaginitis

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THE successful results reported in the use of estrin in the treatment of gonorrheal vaginitis in children aroused our interest and led us to try to determine more definitely the manner in which a gonococcal infection is terminated by a temporary change in the vaginal mucosa as a result of endocrine therapy. It has been suggested that the exfoliation of the epithelium resulting from such treatment might aid in throwing off the organisms. It has also been suggested that the formation of a zone of cornification in the functional layer of the mucosa prevented penetration of the gonococci and so resulted in a cure.

For many years the acidity of the adult vagina has been recognized as inimical to the gonococcus. Kelly, for example, in his *Medical Gynecology* (1908) mentions this fact. Hall and Lewis (1936) found that the normal vaginal secretions of immature monkeys measured by a potentiometer was definitely alkaline, hydrogen-ion concentration 7.5-8.0. After hypodermic treatment with estrin the secretions became strongly acid, hydrogen-ion concentration 5.4-5.7. Four weeks after the treatment with estrin was discontinued the secretions became again markedly alkaline, hydrogen-ion concentration 8.6-8.8. In view of the well known fact that, *in vitro*, the gonococci grow best in an alkaline medium and usually do not survive if it is rendered acid below a hydrogen-ion concentration of 6.0, the suggestion was made that a change of reaction, to acid, of the vaginal secretions of children with estrin similar to that found in monkeys might easily account for the destruction of the gonococci. We believe that such is the case, basing our opinion on the observations reported later in this paper.

Many years ago Doederlein called attention to the importance of the acid secretions of the vagina as a mechanism of defense against intra-uterine infections. He believed that the presence of the acid-forming bacteria, which later were named for him, accounted in a great measure for the vaginal acidity which is in such extraordinary contrast to the alkalinity of the cervical secretions. It has since been shown frequently that the vaginal acidity often destroys pathogenic organisms which may be introduced into the vagina, particularly during pregnancy.

Since Doederlein's discovery, attention has been focused on the importance of the glycogen-containing cells lining the vaginal mucosa, in rendering the secretions acid. These cells form lactic acid as they break down, partly as a result of enzymatic action and partly as a result of the activity of acid-producing bacteria.

Cruickshank and Sharman (1934) have given an admirable review of the observations made on the histology, glycogen content, acidity, and bacteriology of the vagina at all periods of life. When estrin is present, i.e., at birth and very shortly after, as well as from puberty to the menopause, one invariably finds that the vaginal mucosa is made up of many layers of glycogen-containing cells. The reaction of the secretions is typically acid, and normally the bacterial flora is predominantly of the bacillary type. In the absence of estrin during childhood and after the menopause, one finds a thin vaginal mucosa with few layers of cells, an alkaline or nearly neutral reaction of the vaginal secretions, and a mixed flora consisting essentially of cocci.

The figures published in various observations of measurements of the vaginal acidity noted at different ages vary somewhat, probably because different techniques were used in making the determinations. All observers agree, however, that the marked acidity of the vaginal secretions between puberty and the menopause is in sharp contrast to the slight alkalinity or nearly neutral reaction during childhood. Regardless of the method employed to measure the hydrogen-ion concentration, the general differences in acidity during these life periods has been found to be strikingly similar.

In order to determine the reaction of the vaginal secretions, we used 1 or 2 cubic centimeters of sterile physiological salt solution adjusted to hydrogen-ion concentration 7.0. This was expelled into the vagina from a sterile pipette and withdrawn several times to get a fair sample of vaginal washings The hydrogen-ion concentration of a drop of these washings was easily deter-

mined, the following color indicators being used in their respective ranges; brom-thymol-blue (pH 6.0-7.6), brom-cresol-purple (pH 5.2-6.6), and brom-cresol-green (pH 4.0-5.6). A number of the readings obtained with the use of these color indicators were checked with electrical determinations of the hydrogen-ion concentration, and the results corresponded remarkably closely. For the physician treating a case of gonorrheal vaginitis, this method is easily applicable for determining whether or not the estrin reaction has occurred. It is carried out as follows: a drop of brom-thymol-blue is added to a drop of vaginal washings obtained by the method just described. An immediate change to a deep yellow indicates that the fluid being examined has an acidity very near or greater than hydrogen-ion concentration 6.0. If the resulting color is a very light green or shades into a heavy green or light blue the reaction is more alkaline than hydrogen-ion concentration 6.0. This method is much more rapid and more easily carried out than is the examination of microscopic sections of biopsies or stained smears. We have compared all three methods and have found that when the colorimetric determination of the vaginal hydrogen-ion concentration indicates that it is 6.0 or below, the vaginal mucosa is found to have responded well to the treatment with estrin.

In a series consisting of 17 normal children, the youngest of whom was aged 4 months and the oldest 10 years, we found the vaginal secretions to have an average hydrogen-ion concentration of 7.2. The lowest value obtained was 7.0 and the highest 7.4. Cruickshank and Sharman (1934) studied a series of children in the same age group as those observed by us and found that the average hydrogen-ion concentration ranged between 7.4 and 7.8. In only one of our cases in this group were Doederlein's organisms demonstrable in culture. This child was 10 years old and had a vaginal hydrogen-ion concentration of 7.4.

In 10 children with gonococcal vaginitis measurements of the vaginal acidity gave an average hydrogen-ion concentration very near the neutral point. The individual readings obtained are as follows: hydrogen-ion concentration 7.0, 7.0, 6.8, 6.4, 7.2, 6.8, 7.4, 7.2, 7.2, 7.4. Tissue destruction as evidenced by the presence of pus probably explains some of the lower figures in this group. Cultural examinations of the vaginal washings for the Doederlein organism were negative in every one of these cases.

In Table I are shown a group of 11 consecutive cases of vaginitis in which N. gonorrheæ was still present in smears and in which the vagina was found to have a hydrogen-ion concentration of 6.2 or more. They had all been treated by inserting gelatin capsules containing 75 r.u. of amniotin into the vagina at night, just before retiring. No other treatment was given. It will be noticed that in all but one case amniotin had been given for a short time only. Comparison with the hydrogen-ion concentration figures given for the untreated cases shows that the vaginal secretions were already being rendered acid. As a rule approximately 2 weeks of such treatment will result in a vaginal acidity of hydrogen-ion concentration 6.0 or below. One patient failed to produce the usual vaginal acidity even after 5 weeks of treatment. This is rather unusual and may be due either to failure to insert the amniotin capsules (or suppositories) into the vagina regularly, or to some individual idiosyncrasy of the patient's response to the hormone.

TABLE I.—TREATED CASES OF GONOCOCCAL VAGINITIS, SMEAR STILL POSITIVE

Case	Smear for gonococcus	Duration of treatment	pH	% Doederlein organisms
1	+	6 days	6.6	0
2	+	1 wk.	6.8	0
3	+	1 wk.	6.6	0
4	+	1 wk.	6.4	0
5	+	1 wk.	6.4	0
6	+	2 days	7.0	0
7	+	3 wks.	6.0	0
8	+	1 wk.	6.8	0
9	+	?	6.4	0
10	+	18 days	6.4	0
11	+	5 wks.	6.2	0

Table II shows clearly the effect of amniotin in producing a strongly acid vaginal secretion. It will be noticed that, in this series of cases, all of the hydrogen-ion concentration determinations made before treatment was begun were alkaline (between pH 7.2 and 8.0). Every one of these patients was apparently cured when the last hydrogen-ion concentration determination was made. In no case in which the vaginal secretions were found to have a hydrogen-ion concentration of 6.0 or below for any length of time could the gonococci be found in the smear.

In Cases 10 and 11 the vaginal secretions became smear-negative without the production of a strongly acid reaction. Occasionally, under any or no form of treatment, probably as a result of a local tissue immunity, patients with gonococcal

TABLE II.—CASES OF GONOCOCCAL VAGINITIS SUCCESSFULLY TREATED WITH AMNIOTIN

Case	Age-years	Smear for gonococci before treatment	pH before treatment	Duration of treatment days	pH after and during treatment	Smear for gonococci during and after treatment	% Doederlei organisms after treatme
1	9	+	7.2	54	5.4	negative	0
2	3	+		12	6.2	still persists	
				54	4.8	negative	
3	3	+		27	5.8	negative	0
4	4	+	8.0	13	5.6	−	
5	7	+	8.0	13	6.0	+	
				25	5.2	negative	
6	2½	+		13	7.2	+	
				18	6.4	+	
				25	4.8	−	
7	2	+		14	4.8	−	
8	8	+	7.2	5	6.6	+	
				25	5.8	−	
				42	4.6	−	
9	2	+		26	7.0	+	
				31	6.2	−	
				38	4.8	−	
10	5	+	7.8	13	7.0	negative	
				20	4.0	negative	
11	3	+	7.6	13	7.0	negative	
				19	6.2	negative	
12	5	+	7.2	12	4.8	negative	
13	2	+	7.8	14	5.2	negative	
14	5	+	8.0	25	7.2	negative	0
15	3	+		28	5.4	negative	0
16	4	+		24	5.2	negative	0
17	2	+		14	5.8	negative	0
18	3	+		34	4.8	negative	0
19	5	+		48	5.4	negative	0
20	2	+		16	5.0	negative	75
21	3	+		17	5.0	negative	85
22	5	+		33	5.4	negative	75
23	4	+		36	6.0	negative	5
24	2	+		29	4.8	negative	0

vaginitis recover quickly and spontaneously. We believe that this occurred here.

In several instances a number of determinations of vaginal acidity were made during the course of treatment. The results are shown in Table II. Special attention is called to Cases 2, 5, 6, 8, and 9. Usually the smears remained positive until the vaginal secretions were more strongly acid than hydrogen-ion concentration 6.2. They then promptly became negative.

It is interesting to note that relatively few cultures showed the presence of the Doederlein organism. Occasionally this bacterium was found to be present when the vaginal reaction remained neutral or faintly alkaline.

CONCLUSIONS

1. The administration of estrin to children renders the vaginal secretions strongly acid.

2. This acidity of the vaginal secretions is in

all likelihood the important factor concerned in doing away with gonococcal infections, when children so infected are treated with estrin.

3. The acidity of the vaginal secretions is easily measured and gives easily obtained reliable proof that estrin therapy has brought about the desired histological reaction of the vaginal mucosa.

4. Doederlein's organism was present in only a few of the children examined and its presence or absence could not be correlated with the acidity or alkalinity of the vaginal tract.

We acknowledge with appreciation the assistance given us by Dr. Eleanor H. Adler. We are indebted to her for generous contributions of her time and skill in making a considerable number of the hydrogen-ion concentration determinations which appear in the tables in this article. Dr. C. Hendee Smith was also most kind in allowing us access to the patients in the Children's Medical Service of Bellevue Hospital, Department of Pediatrics, New York College of Medicine. The majority of the patients examined and reported on in this paper were from this service.

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PREPARATION OF SAFE INTRAVENOUS SOLUTIONS[1]

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THE production of a reliable supply of parenteral fluids in otherwise adequately equipped hospitals has been hindered by the lack of simple apparatus in which chemically pure solutions can be dispensed safely and economically. The technique to be described employs apparatus designed to provide easy sterilization, safe storage under hermetic seal, and ready administration from the original container.

Fear of the symptom complex "intravenous reaction" has discouraged many from using parenteral fluids. Despite convincing evidence as to the real cause of such reactions, clinicians are loath to abandon individual susceptibility; impurities from chemicals, rubber, and glassware; the velocity of injection; or the volume, temperature, or hydrogen-ion concentration of the injected solution as the etiological factors. Pyrogenic substances, chiefly bacterial toxins, have been demonstrated as the responsible agents (1, 3, 5, 6, 7, 8, 9, 13). Chemically pure, sterile solutions injected into the vein will not cause untoward reactions (4, 10).

There are but two fundamental requisites for a safe supply of parenteral fluid—an unlimited source of freshly distilled water and centralized responsibility for cleanliness in the preparation of the solutions and apparatus.

Singly distilled water from a still equipped with adequate baffles and traps or with a refluxing condenser is safe (1, 2, 4, 10). Sufficient water for immediate use is best collected in pyrex carboys (Fig. 1). These carboys must be sterilized by flushing with live steam from the still prior to collecting the distillate and must be drained dry after use, since distilled water can be stored only when sterile and sealed.

The pyrex glassware used in preparing the solutions is washed with hot soapy water and rinsed with tap water. It is then filled with a cleaning fluid composed of 10 per cent potassium dichromate in dilute sulphuric acid to remove adherent fungi and grease from the inside of the flasks and to leave the pyrex chemically clean. After 12 hours the fluid is poured off and the glassware rinsed thoroughly with 8 successive small quantities of distilled water (Fig. 2). The glassware is then inverted to drain and must be used within 2 hours or recleaned.

Isotonic sodium chloride solution (0.85 per cent) is prepared from a fresh stock solution made by adding distilled water to 170 grams of chemically pure sodium chloride[2], previously weighed out in a counterbalanced flask, until a net weight of 1,108 grams has been reached. The flask is stoppered with a clean rubber stopper and shaken until solution is complete. This stock solution is then filtered through a fritted glass filter,[3] with the aid of suction, directly into a 300 cubic centimeter pyrex burette (Fig. 1). Fifty cubic centimeters of the filtrate are measured into a counterbalanced short necked, thick

[2] Merck's and Mallinckrodt's contain least particulate matter.
[3] Jena fritted glass filter No. 17-G-4.

[1] Read at the combined meeting of The Boston Surgical Society and The Philadelphia Academy of Surgery on February 3, 1936.

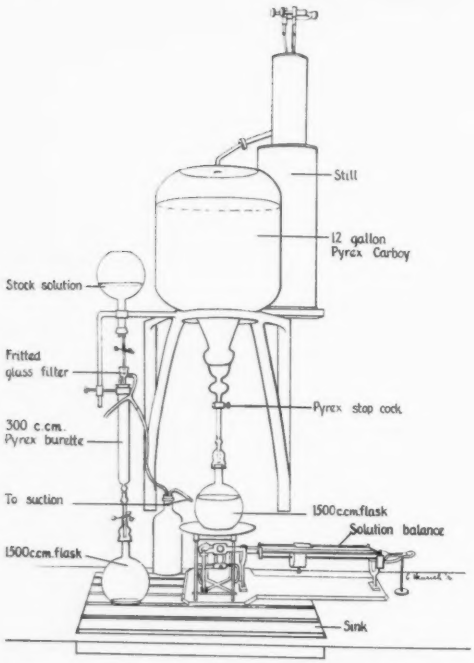

Fig. 1. Arrangement of apparatus to facilitate the preparation of parenteral fluid by a technique which avoids mass filtration and volumetric transfer of fluid.

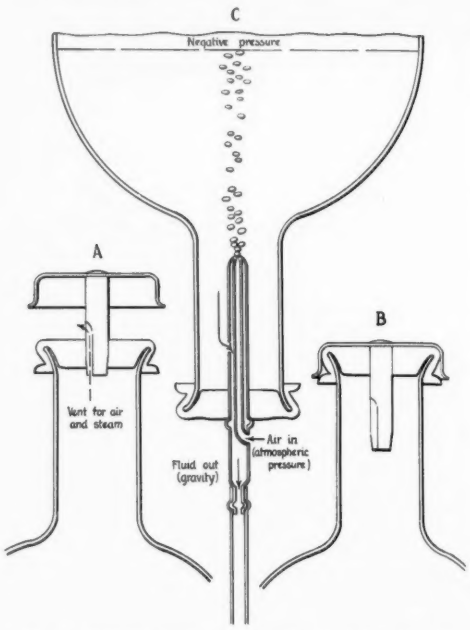

Fig. 3. Hermetic seal permits ready administration from the original container. A, The channel in the steel stopper permits escape of air and steam during sterilization. C, Air enters the capillary orifice to relieve negative pressure within the inverted flask. B, A vacuum seal is produced by inserting the stopper into the bushing and permitting the flask to cool.

walled, pyrex flask, and distilled water is added to a net weight of 1,049 grams. A clean rubber bushing is fitted into the mouth of the flask, its skirt is turned down, and the channeled stem of the steel stopper (11) is partially inserted into the bushing (Fig. 3, A). The channel in the stem provides for the escape of air and steam during sterilization. The solutions are sterilized immediately in an autoclave at 250 degrees F. for 15 minutes.[1] After sterilization the steam supply to the autoclave is shut off and the autoclave permitted to cool to 200 degrees F. before it is opened. In this way, concentration of solution resulting from the ebullition of steam that follows sudden relief of pressure is avoided. As the flasks are removed from the autoclave, the steel stoppers are pushed in to complete the seal (Fig. 3, B). Sufficient vacuum forms during cooling to produce a water-hammer when the flask is jarred, thus providing a ready check on the sterility of the solutions. If the autoclave pressure has been relieved too soon, the hiss of the steam as it rushes through the channel in the steel stopper warns the operator that the solutions have been spoiled. The sterile, sealed solutions can be stored indefinitely without impairing their value as safe parenteral fluids.

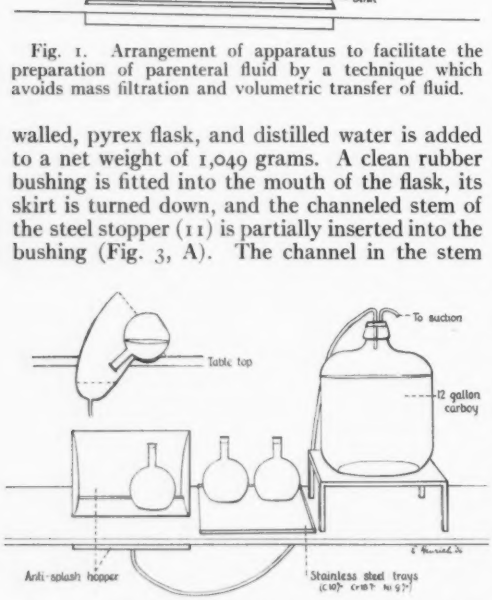

Fig. 2. Cleaning fluid is siphoned into the flasks from the carboy. After 12 hours the flasks are emptied by tipping them into the hopper whence the acid is returned to the carboy by suction.

[1] Temperature of the solution itself (12).

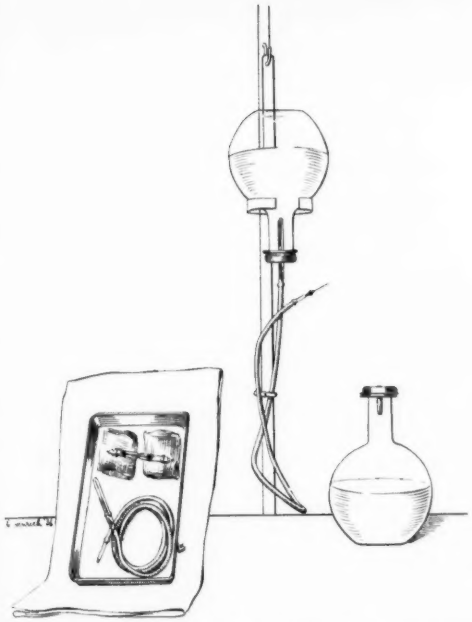

Fig. 4. Apparatus for the administration of parenteral fluid; preparation, sterilization, storage, and administration of fluid are accomplished in individual flasks. The necessary glassware, tubing, and needles are sterilized in a central supply room.

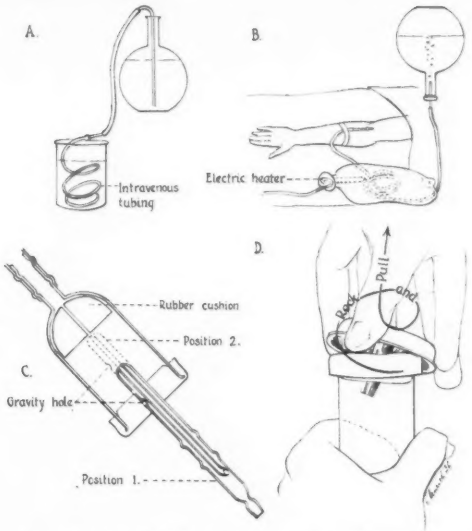

Fig. 5. A, Method of providing continuous flow of alkali through the rubber tubing during cleansing. This apparatus can be set up inside an autoclave as well as over a hot plate. B, Method of heating the solution if desired. Heat applied elsewhere has little effect. C, The pyrex vent tubes are easily cleansed by sucking freshly distilled water through them. In position *1* the gravity outlet is occluded while the air tube is rinsed, at *2* both passages are cleansed. D, the stainless steel stopper is readily removed by a rocking, spiral motion.

To prevent contamination of non-pyrogenic fluid, the utmost cleanliness of the inside of the tubing and needles is essential. The "bloom" is removed from new rubber by treating it with 5 per cent sodium carbonate solution in an autoclave at 250 degrees F. (Fig. 5, A), for 30 minutes. The rubber is then rinsed with 1 per cent hydrochloric acid followed by distilled water. Care must be taken that the inside of the tubing is full of solution, otherwise the inner surface, which comes in contact with the parenteral fluid, will not be properly cleaned.

After use on the ward, the apparatus is washed with cold water and returned to the central supply room, where it is cleaned immediately prior to sterilization. All the parts are separated and washed thoroughly with hot soapy water and rinsed in cold tap water for 30 minutes. The inside of the parts must be thoroughly cleaned. The glassware is immersed in the acid cleaning fluid for 12 hours and then rinsed thoroughly with distilled water. The tubing is coupled together with glass connectors and boiled for 45 minutes in a 0.5 per cent solution of sodium hydroxide. The alkali, from a convenient reservoir, is run through the tubing continually during the boiling (Fig. 5, A). After the tubing is cool, distilled water is run through it for 30 minutes. The needles are washed in hot soapy water and rinsed in distilled water. The parts are dried on a clean, dust free sheet with the aid of suction, and assembled. The needles, without stylets, are placed in an hourglass tube plugged with loose cotton. This equipment is arranged in a clean aluminum pan (Fig. 4) wrapped in a double-thickness muslin sterilizing envelope and autoclaved for 15 minutes at 250 degrees F. If the sets are not used within 10 days they must be resterilized.

The fluid is administered from the original container by removing the steel stopper with a rocking, twisting motion (Fig. 5, D). An inrush of air as the stopper is removed assures the user of the sterility of the contents of the flask. A pyrex vent tube is then pushed into the hole in the rubber bushing as far as the shoulder. This tube acts as a capillary valve for the admission of air as the solution leaves the flask by gravity

TABLE I.—DIRECTIONS FOR MAKING DIVERS SOLUTIONS

Solution	Chemicals in stock solution	Net weight of stock solution, gm.	c.cm. added to flask, c.cm.	Net weight of flask*, gm.
5 per cent dextrose in distilled water	1,000 gm. dextrose c. p.	2,355	100	1,066
10 per cent dextrose in distilled water	1,000 gm. dextrose c. p.	2,355	200	1,085
0.85 per cent saline	170 gm. sodium chloride c. p.	1,108	50	1,049
5 per cent dextrose in 0.85 per cent saline	(a) 1,000 gm. dextrose c. p. (b) 170 gm. sodium chloride c. p.	2,355 1,108	100 50	1,066
10 per cent dextrose in 0.85 per cent saline	(a) 1,000 gm. dextrose c. p. (b) 170 gm. sodium chloride c. p.	2,355 1,108	200 50	1,086
Ringer's	9.0 gm. potassium chloride c. p. 7.4 gm. calcium chloride c. p. 209.8 gm. sodium chloride c. p.	1,145	50	1,575
50 per cent dextrose	1,000 gm. dextrose c. p.	2,406	105	
50 per cent sucrose	1,000 gm. sucrose c. p.	2,418	105	

*Allowance has been made for a 5 per cent loss during sterilization.

(Fig. 3, C). The flask is inverted and hung in the split ring bracket. The rubber tube and needle are filled with solution and the infusion may be started (Figs. 4 and 5).

More than 1,000 cubic centimeters of solution may be given by substituting a second flask as the first one is emptied. This is done by clamping off the rubber tube with a Hoffman clamp prior to removing the vent tube and reinserting it into the bushing of a fresh flask of solution.

If a sufficient supply of sterile sets of pyrex vent tubes, rubber tubing, and needles are kept on hand, the solutions are instantly available and rational parenteral therapy is constantly at the disposal of the clinician.

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DIFFUSE CAVERNOUS ANGIOMA OF THE LEG

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HEMANGIOMA or angioma, as we shall call it in this paper, in contrast to lymphangioma, is an overgrowth and dilatation of blood vessels, which are abnormal in character. These vessels have certain neoplastic characteristics and may at times assume malignant qualities. Angioma is distinguished from the ordinary dilatations and overgrowths of vessels seen in varicose veins, granulation tissue, and highly vascular cellular tumors, by the fact that the latter are the responses of normal vessels to disease or to the demands of the body for greater local blood supply, which disappear when the demand ceases. They are of three types: (1) simple angioma; (2) plexiform angioma; (3) cavernous angioma. Simple angioma, the common nevus, is a congenital dilatation and overgrowth of the capillaries of the skin. It does not grow but may be the starting point for deeper vascular tumors. Plexiform angioma is a congenital overgrowth of the skin capillaries and venules in which the vessels grow in length and thus pile up nodules which may acquire considerable size. They grow but do not infiltrate or destroy other tissues. Cavernous angioma is a congenital overgrowth, hypertrophy, and dilatation of abnormal vessels which tend to grow and infiltrate the surrounding tissues. According to Ewing they undoubtedly have their origin in a developmental anomaly in the structure of certain vascular segments which do not fit into the general circulatory system but retain embryonic characteristics. This thesis is developed by De Takats. He insists that these vascular tumors are not true growths, but are due to faulty development of the blood vessels themselves, and that the variations in the tumors depend upon the amount of differentiation from the embryonal type. They may occur in many parts of the body: in the liver (7), in bones, particularly the bodies of the vertebræ, in joints (9), and, somewhat rarely, in skeletal muscles. It is to the discussion of cavernous angioma of the skeletal muscles that this paper is devoted.

OCCURRENCE

These tumors occur most frequently in persons under 30 years of age. In 1930, Davis and Kitlowski collected 212 cases of cavernous angioma of skeletal muscle from the literature, and reported several of their own. In 1932, Jenkins and Delaney found 61 additional cases in the literature and reported one of their own, but eliminated 18 of Davis and Kitlowski's cases, giving a total of 256 cases reported up until 1932. I have found one more reported case (11) and herewith present 4 of my own. In the reported cases, muscles in the various parts of the body are about equally affected, although there is a slight preference for the lower extremity. All of my cases occurred in the lower leg. This is in contrast to an analysis of 1,674 angiomas of all types (10) made in 1924, in which only 9 per cent were in the lower extremity.

PATHOLOGICAL ANATOMY

These tumors are essentially a dilated mass of thin walled blood vessels lined with endothelium and supported by a delicate stroma of fibrous tissue. These dilated vessels arise from capillaries, arteries, or veins, probably through a process of endothelial hypertrophy which leads to blocking of the lumen of the vessel, which in turn causes back pressure and dilatation. New vessels are constantly added by proliferation of endothelium into bud-like processes which grow and form channels into which blood pushes. These new vessels, in turn, dilate to add to the mass of the tumor. In parts where active growth is taking place, the tumor is very cellular and the new vessels cannot be recognized. In these areas there is an actual shortage of blood supply or anemia. The connective tissue supporting stroma may vary greatly in amount. On the amount of this connective tissue depends the consistency of the tumor. Thrombosis of the dilated vessels frequently occurs and this is followed by organization with formation of dense masses of fibrous tissue. This process may be so widespread as to halt the growth of the tumor. Many of these tumors are encapsulated, in which case they are relatively harmless and are readily removed. If they are unencapsulated, or break through the capsule, they are capable of extremely diffuse growth and much destruction of surrounding tissues. Myelated and unmyelated nerve fibers and embryonic lymphoid tissue sometimes appear in the tumor.

The anemia caused by endothelial proliferation at the edges of the tumor cuts off the blood supply of the muscles which are being invaded, and they degenerate and are gradually replaced by the tumor. In the encapsulated common type, this process does not go far, but in the unencapsulated, infiltrating, and relatively rare type, the muscle

destruction is widespread, may be penetrated, and nerves invaded or even destroyed, as in the case of Stewart and Bettin. Even the bones may not escape the effects of these infiltrating tumors. Irritative periosteal thickening, pressure atrophy, and actual invasion of the medulla by the tumor substance occur (2). Whether or not the tumor actually invades the larger blood vessels is still under discussion, but the fact that in one of my cases and in the case of Bell and Inglis, the posterior tibial artery could not be identified at operation or autopsy, would seem to indicate that it does. This infiltrative and destructive process may go so far as to necessitate amputation.

The clinical course of the infiltrating, non-encapsulated cavernous angioma is an insidious one. The first sign of its presence is usually an ill defined soft swelling which may appear at any time after birth. This may remain stationary for a long time or may grow steadily. Sometimes an injury may be followed by more rapid growth. Frequently, in its early stages, this swelling is unaccompanied by symptoms. As the mass grows, symptoms and signs appear which are dependent on the morbid anatomy of the particular tumor. The first symptom usually is pain. This pain is of three types: (1) a feeling of fullness and heaviness with a stretching sensation which is caused by distention of the blood spaces within the tumor. This type of pain is relieved by rest and elevation of the limb, by which the tension within the vessels is reduced. (2) A radiating pain similar to the root pains of severe sciatica, which is caused by pressure on, or infiltration of, the nerves themselves. This pain is often so severe as to cause loss of sleep and inability to use the limb, and is accompanied by protective spasm of the muscles. It may or may not be relieved by rest and elevation. (3) The third type is extreme sensitiveness to touch or pressure, and is probably caused by irritation of the new nerve tissue which sometimes grows within the tumor. It disappears when the limb is protected from trauma. The second most common symptom is muscle weakness. This is dependent on the actual destruction of muscle tissue and varies with the amount of that destruction.

Swelling is the most common objective sign. This swelling may be soft and compressible, decreasing with elevation of the limb, or it may be firm and non-compressible. It is subcutaneous or subfascial. It is within the muscle substance. If the swelling is painful or tender, there is protective muscle spasm. Engorged superficial veins or varicose veins often overlie the swelling. The skin may be hot and red.

The roentgen-ray appearance of these tumors is misleading because in the roentgen-ray the soft parts show only swelling, in most cases, while the bone changes, whether periosteal thickening, localized enlargement, or local atrophy are not characteristic. Occasionally the roentgenogram may show a mottled appearance of the soft parts suggesting gas in the tissues. This is produced by the large blood spaces in the more vascular tumors. The bone changes are those of periosteal thickening, cortical thickening, or of pressure atrophy.

Diagnosis is difficult in most of the cases. It should be based on the history of the case as to the time of the appearance of the tumor and its duration, on its early lack of symptoms, on its gradual growth, and on the gradual appearance of the symptoms detailed. Physical examination should reveal the fact that the tumor is intramuscular. If it is large when the limb hangs down and decreases in size when it is elevated, its nature should be suspected. The softer and more compressible the tumor, the more likely it is to be an angioma, but often the tumor is hard and firm because of the large amount of fibrous tissue it contains. Differentiation from diffuse lipoma, from fibroma, from sarcoma, from aneurism, and from multiple neuroma, must be made.

TREATMENT

Treatment of angioma of muscle is difficult. In the simple encapsulated type, surgical removal is comparatively easy, as shown in the case reported by Kleinberg. If, however, the removal is not complete, recurrence may occur. In the diffuse type the difficulty of successful treatment is evidenced by the numerous methods which have been advanced. Coagulation by the injection of chemicals has been tried with success in small tumors, but in the large ones, the difficulty of reaching all parts of the tumor and the dangers of necrosis and poisoning have led to its abandonment. Cauterization by the electric cautery has failed for similar reasons. Long continued pressure in the hope of thrombosis of the mass has never succeeded. Roentgen-ray and radium, although apparently successful in the treatment of cavernous angioma of the vertebral bodies, have not yet proved their value in the muscle tumors. Surgical removal offers great technical difficulties because the tumor is so widespread and involves so many tissues, and because of the very real dangers of hemorrhage. I have found few reports of successful surgical removal of a large tumor. On the other hand, amputation has been resorted to frequently (10). Nevertheless, I believe that

surgical removal of the tumor, perhaps in more than one stage, is feasible and offers the patient an excellent chance for a useful limb.

The following cases are presented in support of this belief, to accent certain pathological features of the tumors, to present a little more evidence in support of the theory that they are congenital neoplasms, and to protest against the belief that they always recur.

CASE 1. R. S., female, aged 24 years; an only child. She was first seen on June 1, 1919. The family history was irrelevant. The past history showed that as a young girl she had been very active but never robust. About 1911, she had a fall while skating, which she thought bruised her left leg. Some time later she developed a "growth" on the calf of the left leg which was removed by another surgeon. The report of this operation was not obtainable but the patient thought that the growth consisted of varicose veins. The operative area had been tender ever since and had swollen from time to time. During the past year she had worn a bandage on the leg in an attempt to relieve the sense of fullness and "dragging" but this had done little good. The trouble with the leg had greatly restricted her activities because of the discomfort and because of weakness of the calf muscles. She had noticed varicose veins in the back of the leg.

There was nothing abnormal found in her physical examination except the condition of her left leg. This showed several large varicose veins extending upward on the outer and posterior surface from mid-calf to mid-thigh. The left calf was 1¼ inches larger than her right. This enlargement was due to a soft compressible tumor which lay beneath the fascia and seemed to involve most of the bellies of the gastrocnemius and soleus. It was 6 to 7 inches long. It was not tender or painful. The skin over it was not discolored. There were no hard areas in it and it could be made to disappear completely by steady pressure. Operation was advised for the removal of the tumor, which was thought to be a cavernous angioma.

Operation, January 12, 1920, under ether anesthesia. A long external incision in the calf down to the deep fascia revealed nothing abnormal. The fascia was opened and a huge mass of greatly distended, thin-walled vessels presented. The mass did not pulsate and apparently replaced muscle. The vessels tore very easily. They appeared to open into each other in all directions like the structure of a sponge. Considerable parts of the muscle substance were intact and appeared to be pushed aside by the growth. Other parts were infiltrated by it. In order to gain better control of the tissues, a second internal incision was made and a mass of tumor and involved muscle, 7 by 2½ inches, was dissected out. No one vessel could be found which supplied blood to the tumor nor one which emptied it. The posterior tibial vessels were not exposed nor was the nerve. During the removal of the mass there was much hemorrhage, mostly venous, which was controlled by pressure. The remaining good muscle was then sutured over the dead space left by the removal of the tumor. The skin was closed with silkworm gut and a large pressure bandage and splint were applied. It was impossible to hold the foot at right angle flexion because of pressure anemia and pain. Moderate shock was successfully combated by saline hypodermoclysis. There was no secondary hemorrhage.

Following this operation gradual restoration of function was secured, but two small secondary operations for removal of remnants of the tumor and adjacent varicose veins were necessary within the succeeding 6 months. The patient has remained well since, has two children, is moderately athletic and has no symptoms. There has been no recurrence of the tumor and both legs are equal in size, which gives her satisfaction.

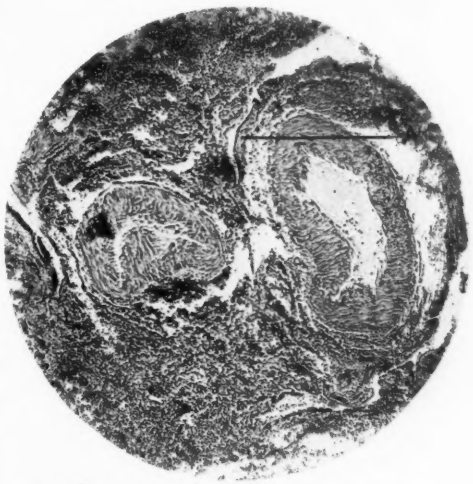

Fig. 1. Case 1. Blood vessels of leg surrounded by tumor growth. Cleft at *A* possibly a vessel bud.

The pathological report by Dr. Plinn H. Morse is hemangioma cavernosum. The growth diffusely infiltrates the muscle and surrounds the blood vessels, in some places producing pressure on and constriction of the original blood vessels. As a result of this mechanical effect, thromboses are produced within the vessel walls, which later fenestrate and resemble somewhat the original tumor growth. (This may explain the illustrations in the article of Jenkins and Delaney. These seem to show actual invasion of a blood vessel by the tumor.) There are some nerve filaments in the sections.

This case is the most typical of our series. It exemplifies the type of pain or discomfort which is due to distention. Speculation as to whether the accompanying varicose veins were coincidental or whether they were a part of the tumor is intriguing. I am inclined to believe that they were coincidental because they were superficial to the fascia, whereas the tumor was beneath it.

CASE 2. Female, aged 10 years, was first seen on June 3, 1931. The family history was irrelevant. The family had known since the child's birth that she had "flat foot" on the left, which was due to congenital malformation of the tarsus. It gave her no trouble until 4 years ago when she had scarlet fever. Immediately thereafter she began to have pain in the left lower leg and to limp. The pain has continued since. It varied in intensity but was generally severe and kept her awake at night. It was burning in character. Pressure, as from a shoe, relieved it somewhat. She slept with the foot pressed against the wall and she liked to keep the leg elevated. The foot was "feverish." About a year ago a "lump" appeared in the left calf.

Fig. 2. Case 2. Engorgement of foot, skin atrophy, deformity of foot, and tumor of calf.

Fig. 3. Case 2. Tumor in tissue and deformity of the left foot.

Physical examination showed a well nourished girl, highly nervous and emotional. She constantly grasped and held her left foot elevated. The foot was in extreme valgus and dorsiflexion, and the knee was flexed at 90 degrees. She removed her shoe and stocking under protest and constantly squeezed the bare foot. Attempts to overcome the contraction of the foot or knee evidently caused great pain. The whole foot and lower leg were extremely sensitive. The inner side of the foot and sole were covered with numerous engorged veins and the foot was hot and red, the skin markings having been obliterated. There was a subcutaneous fullness, as of new growth. There was a large, firm, somewhat compressible tumor in the outer upper half of the calf. This was not adherent to the skin and surrounded the head of the fibula and involved the gastrocnemius. The left calf was 12 inches in circumference, the right $10\frac{3}{4}$ inches. The lower end of the tibia was smaller than the right. The anterior and posterior tibial artery pulsations were well felt, and there was no edema or interference with return circulation.

Operation, under ether anesthesia, was performed on June 9, 1931. A tourniquet was applied. A long posterior

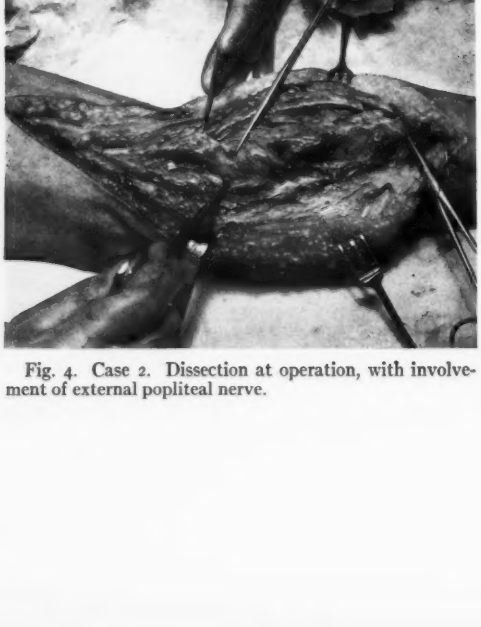

Fig. 4. Case 2. Dissection at operation, with involvement of external popliteal nerve.

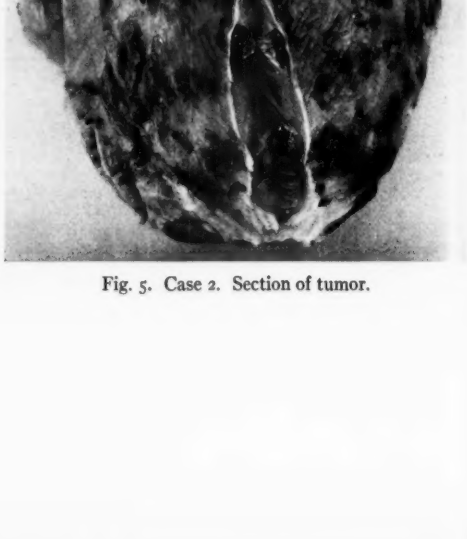

Fig. 5. Case 2. Section of tumor.

Fig. 6. Case 2. Marginal portion of tumor showing compression and atrophy of muscle cells in the zone around *D*. Fragmented muscle fibers with attempts at regeneration at *A*. New forming lymph tissue at *C*. Muscle at *B* more nearly normal except for increased fat tissue.

Fig. 7. Case 2. New forming lymph nodes at *A*. Multiple dilated spaces as at *B*.

incision was made from mid-thigh to lower third of the calf. The external popliteal nerve was first explored in the lower third of the thigh where the sciatic divided. Dissection of the external popliteal nerve revealed, about 2 inches above the head of the fibula, a mass of fibrous tissue and distended blood vessels which infiltrated the nerve, greatly enlarging it for about 2 inches. Below that the nerve was normal. This dissection established the outer border of the tumor, which was firm but filled with large distended blood spaces. The tumor lay under the gastrocnemius, infiltrated the soleus, and was densely adherent to the back of the tibia and interosseus membrane. It extended from the popliteal space to the Achilles tendon. In order to identify and preserve the internal popliteal and posterior tibial nerve, it was necessary to dissect it completely from above, downward, through the mass of the tumor. The tumor did not invade this nerve but was in contact with it. No posterior tibial artery could be found, nor could any vessel of entry or exit be made out. The whole tumor was removed with most of the soleus. The tumor of the external popliteal nerve was carefully dissected, much of it being removed without damaging many nerve fibers. Tourniquet was removed and hemorrhage was controlled by pressure and suture. The wound was closed without drainage. Dry dressing and a plaster cast were applied with the foot and knee in corrected position.

After the operation this girl received two deep roentgen-ray treatments. Six weeks later the spasm of her ham-strings and dorsiflexion of the foot had disappeared, so that her knee and ankle could be normally controlled. All pain in the leg disappeared but moderate pain in the foot has persisted, as has the dilatation of the foot veins, the heat of the foot, and the desire for pressure as a relief from pain. The pain is now limited to an area, 3 by 3 inches, in the inner side of the sole of the foot. Following operation, there developed a thrill in the engorged area in the foot which could be heard as a loud bruit with the stethoscope. This must be due to an arteriovenous connection. Since 1932, when amputation was advised elsewhere, frequent attempts to obtain permission for further operation in the foot area have been made. The parents have just now consented.

Pathological report on this case was cavernous and telangiectatic hemangioma, including many primitive lymph nodes and many small nerve fibers running through the tissues. The tumor in the external popliteal nerve was vascular and fibrous.

Case 3. M. G., male, aged 39 years, laborer, was first seen in Out-Patient Department on June 25, 1933, because

Fig. 8. Case 2. Older portions of tumor showing multiple nerve filaments scattered through hyaline connective tissue as at *A* and *B*.

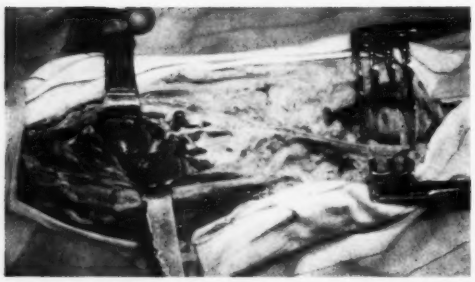

Fig. 9. Case 3. Dissection at operation, showing involvement of nerve trunk and enormous blood spaces.

of pain in his right sciatic distribution below the knee. He spoke little English but a history was obtained that 7 years before he had developed pain in his right calf with swelling. He was in bed 4 weeks and the pain disappeared but the swelling persisted. One year later some large veins appeared in his right lower leg and have persisted. The pain recurred 5 years ago and has remained the same since. It was sharp and shooting in character, began in the back of the thigh, and ran down the outer side of the calf to the ankle. It gradually increased in frequency until it recurred every few minutes. He knew of no way to relieve it except the use of heat (nerve root type of pain). The right calf has been enlarged for 6 years and has grown larger lately.

Physical examination revealed a normal man except for the back and lower extremities. The lower back was somewhat stiff and roentgen-ray showed some degenerative changes. The right sciatic nerve was tender at the sciatic notch and bending his back increased his usual low sciatic pain. There were a few varicose veins of both lower legs. The right calf was definitely enlarged (2 inches). The enlargement was due to a soft tumor mass occupying the upper and outer two-thirds of the gastrocnemius muscle, extending into the popliteal space and surrounding the head of the fibula. It was largely within the muscle body. It was not tender and was somewhat compressible and decreased in size on elevation. The external popliteal nerve was tender. The skin was normal. Wassermann test was: Negative. Diagnosis: cavernous angioma involving the gastrocnemius and external popliteal nerve.

Operation, gas and ether anesthesia, tourniquet, on February 18, 1933. An incision 12 inches long was made over the outer side of the popliteal space, extending down over the calf. Nothing abnormal was found outside the deep fascia and the fascia was normal. On incision of the fascia, masses of distended, irregular, thin walled blood vessels were found. These extended in all directions in the gastrocnemius and soleus. Dissection of the lower external popliteal and upper posterior tibial nerves revealed that they were invested by masses of these veins which surrounded them and often entered their substance. In the muscle these veins were clamped and tied and widely incised without an attempt to remove them radically because the necessary damage to the muscle did not seem justified. In like manner those investing the nerves were incised and dissected off without damage to the nerve. After removal of the tourniquet, bleeding was stopped by suture of muscle, pressure, and clamping. The wound was closed without drainage. Unfortunately, the specimen from this operation was lost and there is no pathological report. The gross appearance was identical with that in Case 1 and we feel justified in persisting in the diagnosis of cavernous angioma.

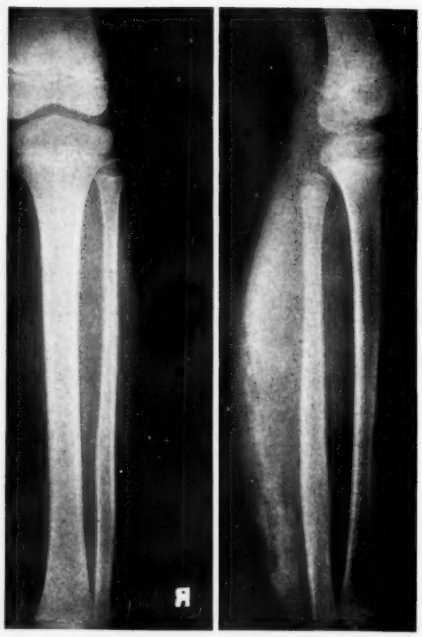

Fig. 10. Case 4. Tumor in soft parts, hypertrophy of fibula and atrophy of tibia.

Immediately after operation the paroxysmal low nerve pain disappeared and had not returned when the patient was last seen, 3 months later. At that time the swelling of the leg had disappeared and there was no sign of recurrence. We have just received a report from this man's friends to the effect that he is living in the South and is working and well.

Case 4. T. Z., male, aged 8 years, was first seen on October 23, 1935. The family history is unimportant. Patient was always healthy but not a robust boy. He had measles 4 years ago. Three years ago a swelling in the lower right leg appeared and a limp developed. There were no signs of infection nor was there any injury. Various examinations had been made but no diagnosis. There had been no treatment. One year ago he was confined to bed for a few days by pain in the swollen leg. He complained of the swelling in his leg, that the swelling was extremely sensitive to any trauma, that the leg was a little weak, and that it ached when he got tired. He had no pain when he was at rest. He had no fever. The trouble partially incapacitated him because he was afraid of getting his leg hurt.

Physical examination showed a small, somewhat delicate but very sunny, bright boy. Nothing abnormal was found except the right lower leg. To the outer side of the Achilles tendon in this leg there was a soft subcutaneous swelling which was not adherent to the skin. This extended upward somewhat. The measurements of the two legs were: left calf, 9¼ inches, right calf, 9¼ inches; 1 inch above the external malleolus—left, 6¾; right, 7¼ inches; 4½ inches above the malleolus—left, 7⅞; right 8⅝ inches. This swelling overlapped the fibula behind but had no connection with it, although roentgen-rays showed some

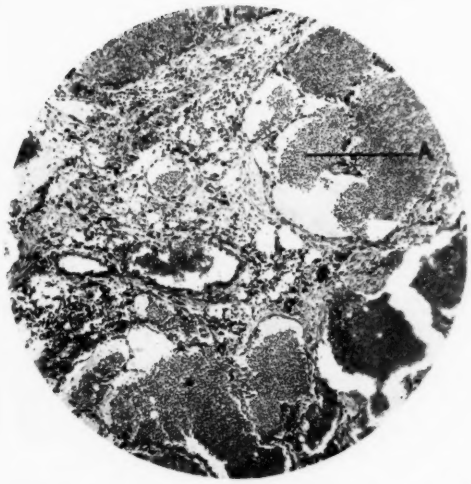

Fig. 11. Case 4. Telangiectatic hemangioma of muscles of calf. Large blood spaces as shown at *A* indicating character of tumor growth.

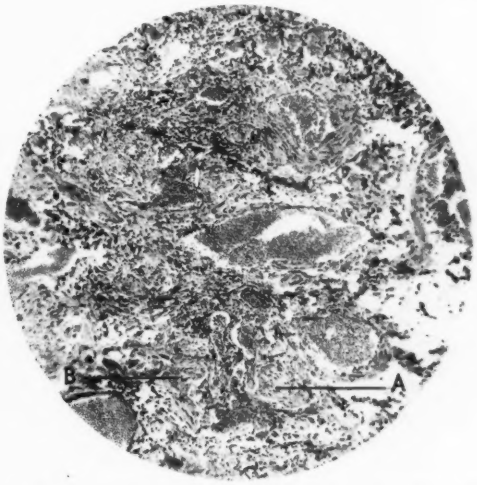

Fig. 12. Case 4. Typical field of angioma invading calf muscles. Note lymphocytic infiltration and multiple nerve fibers at *A* and *B*.

enlargement of the bone at that point. The swelling was extremely sensitive, and this tenderness extended upward through the gastrocnemius muscle. A diagnosis of cavernous angioma was made and operation was advised as the proper treatment.

Operation was performed November 4, 1935; gas and ether anesthesia; tourniquet. A long posterior incision over the gastrocnemius was made. The deep fascia was penetrated here and there by small dilated vessels which connected with deeper tissue. The fascia was split, exposing a widespread mass of large, dilated, thin walled vessels with much dense, supporting fibrous tissue which was, in many parts, extremely cellular, suggesting sarcoma. This infiltrated the gastrocnemius and soleus as well as the peronei and was densely adherent to the fibula. The vessels supplying this mass invaded or came from all surrounding tissues. The fibula was thickened, apparently by the irritation of the tumor. Very wide dissection was carried out but it was impossible to surround the tumor completely. It was removed as nearly completely as possible. Because of the extreme vascularity of this tumor and its connections, the dissection was carried up through the popliteal space, thus exposing the internal and external popliteal nerves and the popliteal artery which were surrounded, but not infiltrated, by the tumor. This was cleared so that it could be clamped readily if the bleeding should be too severe after the removal of the tourniquet. On removal of the tourniquet, bleeding was profuse, mostly from small arteries which had entered the tumor from all directions. These could not be tied but were controlled by pressure while a very rapid suture of the muscle and fascia was done. Meanwhile, intravenous 10 per cent glucose had been started. In spite of rather severe shock, it was possible to close the wound and apply a pressure bandage without tying the popliteal artery. The boy was in poor condition for 12 hours, but reacted well with the aid of glucose and morphine. The circulation in the leg and foot was good. After 10 days the stitches were removed on November 30. Induration and tenderness are still present and the outcome with reference to function and pain is still to be determined.[1]

The pathological report was cavernous angioma of muscle. There are many small nerve filaments running through

[1]This child returned for examination on March 5, 1936. He is entirely free from pain. There is still a little tenderness at the middle of the calf. Fibrous tissue substitution at the site of operation has led to a slight shortening of the Achilles, which prevents dorsiflexion of the foot beyond the right angle. Motions of the knee are normal and the boy is beginning to walk. He is still wearing a plaster splint at night.

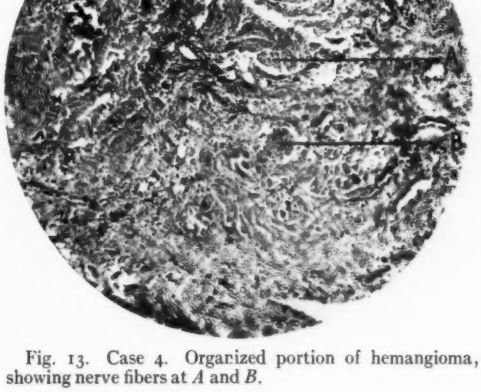

Fig. 13. Case 4. Organized portion of hemangioma, showing nerve fibers at *A* and *B*.

the mass and areas of lymphoid tissue with small germ centers are present. There is some degenerative fatty change.

Operative removal of cavernous angioma has proved feasible though difficult in these 4 cases. In Case 1 minor secondary operations were necessary, but there has been no recurrence in 15 years. In Case 2 the first operation gave great relief and removed the bulk of the tumor, which has not recurred in 4 years. Secondary minor operations are necessary. In Case 3 surgical destruction of the tumor apparently was completely successful. In Case 4 removal of the tumor, although not complete, was 90 per cent successful. The pain in Case 1 was due to distention and was of the first type of pain. It was completely relieved. The pain in Case 3 was of the second or nerve root type and was due to pressure on and invasion of the nerves. It was completely relieved by operation. The pain in Case 4 was of the third type and was due to the pressure on sensory nerves in the tumor. It was not relieved. The pain in Case 2 was a combination of the second and third types. It was completely relieved in areas from which the tumor had been removed.

The presence of nerve filaments and young lymphoid tissue in the tumors of Cases 2 and 4 puts these 2 cases, without possibility of doubt, in the class of congenital tumors arising from abnormally developing embryonal tissue. Both tumors are preponderantly cavernous angioma. The cavernous angioma, microscopically in Case 1, and macroscopically in Case 3, exactly resembles that in Cases 2 and 4. This resemblance is a very striking evidence that the tumors in Cases 1 and 3 are congenital in origin.

I am indebted to Dr. Plinn F. Morse of Harper Hospital for the preparation of the pathological material and for advice from the pathological point of view.

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A SIMPLE TECHNIQUE FOR THE CURE OF HYPOSPADIAS[1]

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THE term "hypospadias" was apparently created by Galen. However, little was known about its origin until the development of embryology, and most of the early literature is concerned with unsexing alleged females afflicted with this deformity. Hypospadias is a mal-development of the penis and urethra caused by a failure of fusion of the urethral groove which normally folds together in the male embryo by the end of the tenth week. The genital ridge is essentially the same in both the male and female up to the eighth week. After this, fusion rapidly takes place in the male as indicated in Figure 1.

It is not an uncommon condition, being present, according to Rennes and Bouisson, in 1 out of every 300 males. A very distinct hereditary tendency has been shown by Lingard who traced 6 generations in which transmission always occurred from father to son. Lecat stated that in Normandy minor degrees of hypospadias frequently run in families.

The anomaly varies from a slight almost imperceptible defect (Fig. 2) to a complete absence of the penile urethra and a pseudohermaphroditic appearance (Fig. 3). For clinical purposes it is only necessary to differentiate 4 types: (1) glandular or balanic; (2) penile; (3) scrotal; and (4) perineal.

Indications for operation vary in proportion to the distance of the opening from its normal location. In the balanic type, there is never a real indication for operation although, according to Keyes, even the slightest degree is sufficient to prevent admission to West Point. With this defect in the glans, or just behind it, the patient can urinate normally and his ability to procreate is in no way affected. Many of the patients are unaware of their deformity but occasionally the mere knowledge produces an obsession amounting almost to a psychosis. Such a patient should not be operated upon, and he can usually be dissuaded when all the facts have been presented. It may be a harder task to convince an oversolicitous parent (especially a doting mother).

In the penile type the defect may occur at any point from the glans to the base of the penis. The opening may be slit-like in a transverse direction, ovoid or round, and occasionally the openings are multiple. Whenever such a patient finds it necessary to sit or squat to urinate, he is very greatly handicapped and should be given the benefit of a plastic repair. The gratitude of the patient with a scrotal or perineal defect, when restored to anything like normal, more than justifies the expenditure of patience and meticulous care necessary to obtain a good result.

I have examined over 15 different operations. The mere fact that so many methods have been suggested indicates that no operation has been entirely satisfactory. Dieffenbach is usually credited with having done the first operation, but perusal of his original report shows that no one of his 3 cases was cured. Anger, in 1874, employing practically the Thiersch method, apparently obtained the first successful result (4). Most operations depend upon one of the following principles:

1. The lateral flap principle, that is, some modification of the Duplay and Thiersch operations (Fig. 4). Excellent results have been obtained by this method, but it requires complete diversion of the urinary stream. It is also fol-

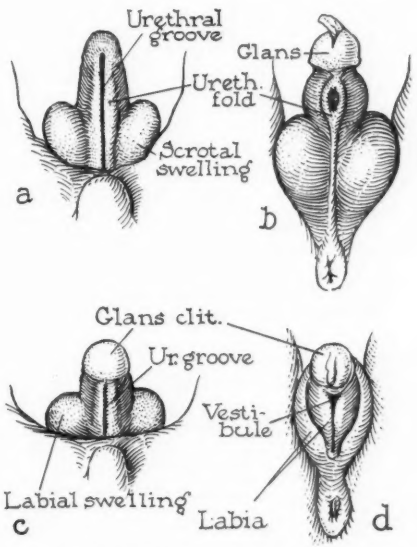

Fig. 1. a, Male embryo at 8 weeks showing the open urethral groove. b, Male embryo at approximately 12 weeks, showing closure of the groove and development of the glans. c, Female embryo at 8 weeks. Note similarity to a. d, Female embryo as 12 weeks, showing development of vestibule.

[1]From Cook County Hospital, Chicago, Illinois. Read before the Western Surgical Association, Rochester, Minnesota, December 7, 1935.

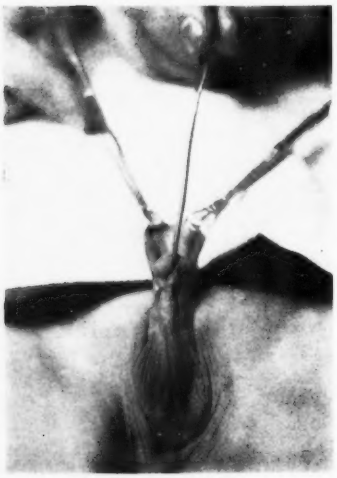

Fig. 2. Slight degree of hypospadias. Note the apron-shaped prepuce.

lowed in some instances by the formation of a fistula which may require several operations to close.

2. The Bucknall principle, which consists in suturing the penis to the scrotum and obtaining scrotal skin to line the under surface of the urethra. Cabot has used this method for years and finds it almost fool-proof, although he has recently raised the objection that the transplanted hair-bearing epithelium may later become the source of trouble.

3. Some modification of the Beck principle, that is, freeing the urethra and carrying it through the glans (Fig. 5). This method can be used only in those cases in which the opening is anterior to the scrotum, and is almost certain to result in a permanently deformed organ.

Fig. 3. Perineal hypospadias with cleft scrotum and pseudohermaphroditism.

4. The employment of the prepuce either as a flap, as in the Ombrédanne method (Fig. 6), or as a tube, such as the method originally described by Wood (quoted by C. H. Mayo), the Mayo method, or the Russell.

5. For a limited number of cases in which the defect is not too great the inverted "umbrella flap" described by Bevan in 1917, gives excellent results (Fig. 7), and it is this principle which I have utilized in repairing more extensive defects.

Most of these methods require a cystotomy, either suprapubic or perineal. Although infection rarely follows vesical drainage in children, it can not be denied that there is certain added risk from such drainage, and stricture of the perineal urethra must occasionally follow, especially if Young's method of constriction of the urethra distal to the perineal urethrotomy be employed.

The method which I wish to present is based upon well established principles, both in plastic surgery and in the treatment of hypospadias. It does not require cystotomy and its simplicity is

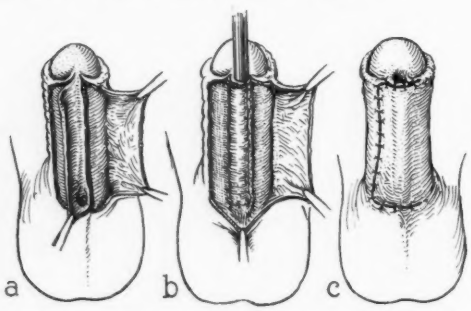

Fig. 4. Cecil's modification of the method used by Thiersch.

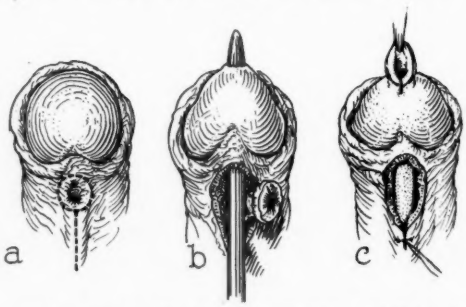

Fig. 5. The von Hacker-Beck operation, mobilizing the urethra and bringing it out through the glans penis.

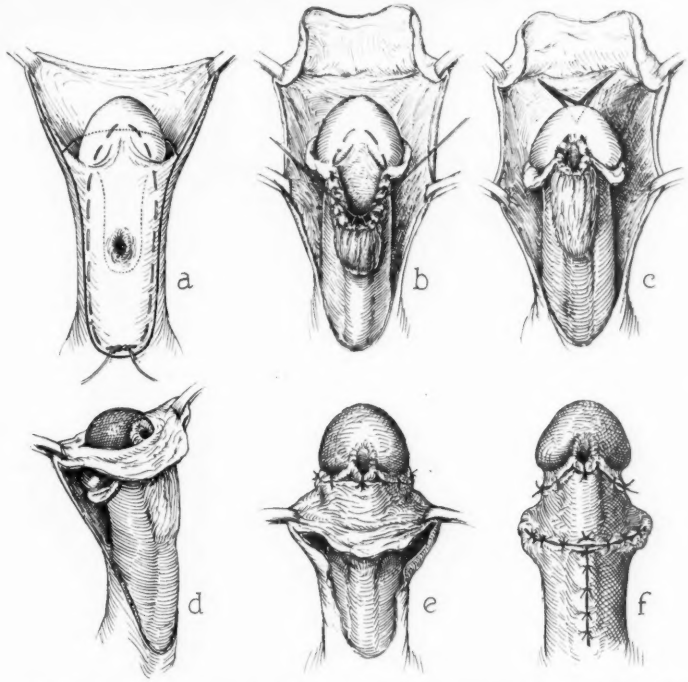

Fig. 6. The Ombrédanne method of repair of perineal hypospadias. The raw surface left after making the new urethra is covered by prepuce which is split, c, perforated, and carried over the glans, d. It is then sutured on the under surface of the penis as indicated in e and f.

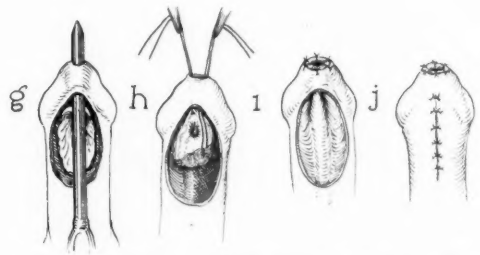

Fig. 7. The Bevan method of repair of perineal hypospadias—used in completing the operation diagrammed in Figure 6.

its greatest recommendation. In the event of failure, the patient's condition is no worse than before operation. There is no question but that the correction of the chordee is an important preliminary step to any corrective operation. As stated by Cabot, the ideal time for this preliminary step is very early, that is, at the age of 2 or 3. However, many of these patients are first seen at 8 or 10. Even at this age a transverse incision followed by careful dissection of Buck's fascia and the removal of *all* the fibrous bands which produce the shortening (Fig. 8) will largely correct the deformity. While the resultant defect is a little startling at times, there is never any diffi-

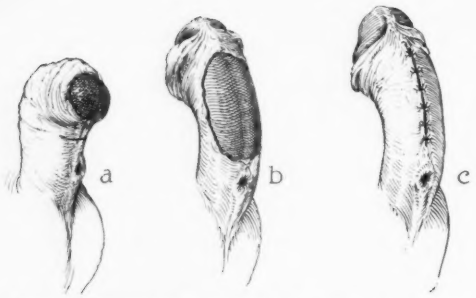

Fig. 8. Correction of chordee by a transverse incision which is closed longitudinally after removal of all fibrous bands.

culty in closing it longitudinally. The reconstruction of the urethra is a multiple stage operation which consists in making so called "umbrella flaps" about the urethral orifice. Each flap should not be more than 2 centimeters in diameter. Great care must be exercised not to button-hole the flap or destroy its viability. A small strip of the lining of the new channel distal to the urethral orifice is not elevated so that the blood supply of the remainder is not impaired. For this dissection I use a special small curved dissecting scissors, resembling a miniature pair of Mayo scissors. The lumen of the new urethral orifice is narrowed by a few interrupted sutures of fine silk. The raw surface of the new urethra is then covered by suturing together longitudinally the skin edges of the defect from which the flap was taken (Fig. 9). Success depends largely upon the care with which the dissection is made and hemostasis carried out. Accurate approximation should be done with interrupted sutures of fine silk. The advancement at any one stage is not great but is sufficient to give the patient very definite improvement. In most instances, I have introduced a soft rubber catheter into the bladder, leaving it 4 or 5 days. Even when it has been expelled earlier the result usually is good. Following the operation the wound is dressed with gauze and a moist sea sponge is applied to hold the penis flat on the patient's abdomen, as suggested by Vilray Blair. The stitches are removed from the seventh to the tenth day, and the patient is discharged from the hospital but kept under observation. Most of these patients can be operated upon during their vacation time so that about a year elapses between stages. When they return, the induration has entirely disappeared and the skin is just as soft and pliable as before the first operation. One may now repeat the operation, carrying the urethra another step forward. In most instances,

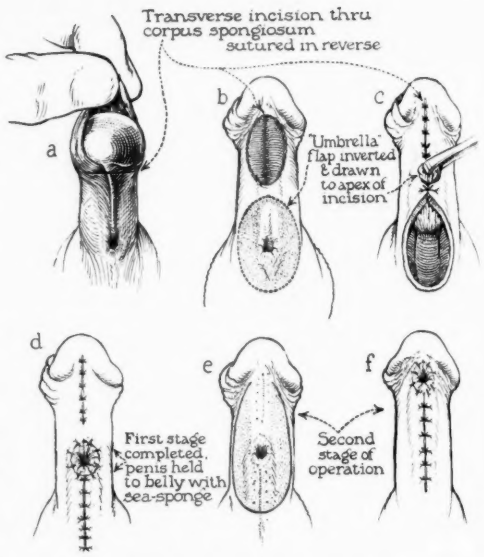

Fig. 9. Multiple stage technique employed in the treatment of scrotal and perineal hypospadias.

two or three stages are all that is necessary. In 3 instances, I have carried the flap through the glans after making a channel with a trocar, as suggested by Dr. Bevan (Fig. 7). In 2 others, I have employed the Ombrédanne flap (Fig. 6) for the final stage.

At the present time I have 5 completed operations, performed on patients suffering from defects of the penile and scrotal type, with what seem to be satisfactory results. I also have 4 other cases in various stages of repair. Whether these results will be as satisfactory when these patients reach manhood remains to be seen, although one boy, now 17, operated on 5 and 4 years ago, has a very excellent result and has been changed from a bashful sensitive child into a perfectly integrated youngster. I have as yet no complaints of difficulty following inversion of hair-bearing scrotal skin. Davis has suggested the use of the roentgen-ray to prevent this complication, but I should be afraid of damage to the testes, as well as the hardening (fibrotic) effect upon the skin. Soft, pliable skin is an essential factor in any reconstruction operation.

SUMMARY

A simple multiple stage operation is suggested for correction of the more extensive types of hypospadias based upon well established plastic prin-

ciples. It does not require cystotomy. The results have been satisfactory to date, although it is too soon to know whether there may be late objections such as have been reported by Cabot, Walters, and Counseller, Churchman, Vermooten, and others.

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SURGICAL CORRECTION OF FLEXION DEFORMITY OF THE KNEES DUE TO SPASTIC PARALYSIS

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From the Orthopaedic Clinic of St. Luke's Hospital

WHEN the surgeon sees a patient with spastic cerebral paralysis, the damage has long since been done, and the opportunity to help is largely limited to amelioration of the symptoms. While treatment of the cause has so far been unsuccessful, the treatment of the effect of this condition offers many possibilities. Some simple surgical procedures often make it, in some instances, possible and, in others, easier for these patients to walk.

These spastics have such lack of co-ordination of their motor power that the stronger muscles overpull their weaker antagonists, and the typical deformities, such as equinus, knee flexion, adductor contracture of the thighs, etc., develop.

The extremely awkward appearance and the difficulty of walking with the knees flexed 20 degrees or more have led to many attempts to correct this handicap. Partial division of the nerves to the hamstrings, lengthening or division of the hamstrings, transplant of the hamstring tendons into the patella, have all been tried with posterior capsulotomy of the knee joint at times. Each of these procedures in certain instances may be of benefit.

Several years ago we were impressed with the idea presented in a paper by Chandler dealing with this question of knee flexion deformity in spastics. Chandler discussed the subject of knee flexion in spastics, described his ingenious operation, and reported his original case.

In every spastic who has had knee flexion since birth, the ligamentum patellæ and the quadriceps are stretched. The patella rides well above the joint line at or above the epiphyseal line instead of having its lower border at the joint margin. Even if the flexion deformity is corrected by any means, the overstretched muscle is at a mechanical disadvantage and can not efficiently work to maintain extension. Therefore it seems extremely logical to take up the slack in the quadriceps extensor by transplanting the tibial tubercle into the tibial shaft 1 inch to 1½ inches distal to its normal insertion.

On some of these patients we have performed a posterior capsulotomy of the knee joint and have also found it necessary to paralyze the hamstrings temporarily by dissection of the sciatic nerve and injection of its branches to those muscles with alcohol.

In fixing the tibial tubercle at its new site, we originally used an ordinary nail and silk suture, removing the nail 3 weeks after operation. More recently we have varied this procedure by transfixing the ligamentum patellæ with an autogenous bone peg and then suturing the periosteum

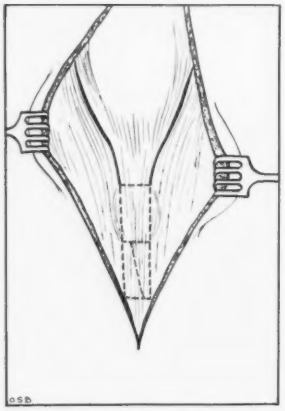


Fig. 1. The front of the knee with the patella and tibial tubercle are exposed. The lines of incision are indicated. In order to draw the tibial tubercle into its new site, it is necessary to divide the capsule of the knee joint high on each side, and it is necessary to enter the knee joint. These points were brought out by Chandler. The bone removed from the cortex at the point where the tubercle is to be transferred can be cut into two autogenous pegs.

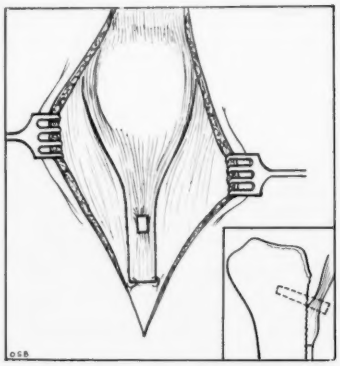


Fig. 2. The transplanted tibial tubercle is anchored in place by the autogenous bone peg which has been driven obliquely into a drill hole in the tibial shaft through the ligamentum patellæ just proximal to the tubercle. The periosteum covering the tubercle is sutured to the periosteum of the shaft by interrupted silk sutures.

with silk. We found that an attempt to drive a peg through the tibial tubercle usually split it. The operative procedure is shown and described in Figures 1 and 2.

We present a detailed study of 5 patients with end-results. Each of them has been materially benefited as far as their knee flexion is concerned. In that they are still spastic, their situation remains unchanged, but in making their locomotion easier, we have accomplished what we set out to do.

CASE REPORTS

Case 1. R. L., St. L. No. 100518, a boy 9 years of age. The patient was admitted to the St. Luke's Hospital orthopedic service June 2, 1933.

He was slow in developing, and when he began to walk at the age of 18 months, it was noted that he was spastic in both legs. From the age of 2 years until the age of 6 years, he was treated every day by a specialist who trained him in muscle control, etc., but without any very noticeable improvement in gait or muscle balance. He was a bright child with a handicap which was purely physical.

On admission he showed marked adductor spasm of both legs, knee flexion, and equino varus of both feet. On June 5, 1933, the adductor longus and gracilis muscles were divided just below the origin, and both obturator nerves were injected with alcohol. Eighteen days after this operation, the adductor contracture was gone, though he still had power to adduct. Wounds were firmly healed.

On June 26, 1933, the sciatic nerve was exposed surgically, and the branches to the hamstrings were injected with alcohol. After each of these procedures double plaster-of-paris spica bandages were applied with the legs widely abducted and knees straight.

One month after the second operation he was allowed up with double stiff leg braces and crutches. He left the hospital, walking, on August 4, 1933, having had an uneventful postoperative course.

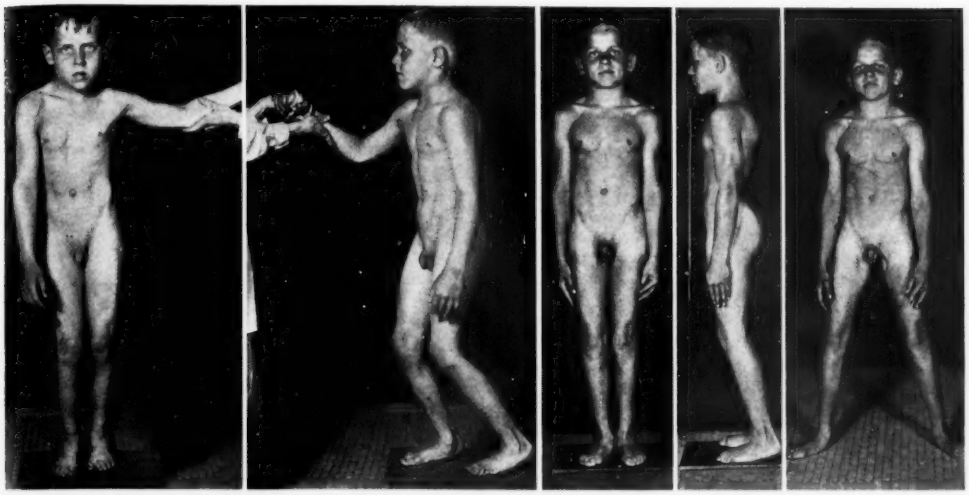
He was readmitted December 6, 1933, and at this time his chief difficulty was knee flexion deformity and equinus. The patellæ were high above the level of the knee joints, and the quadriceps were at a distinct disadvantage. It was decided to transplant the tibial tubercles into the tibial shafts. On December 18, 1933, a bilateral transplantation of the tibial tubercles was done. The ligamentum patellæ was dissected free from the lateral expansions of the capsule, and its insertion was excised with a chisel with a block of bone 2 by 4 by 1 centimeter. A small trough was cut on the tibial shaft 1 inch distal to the former insertion. The block of bone was sunk into this trough and held with a wire nail. Plaster splints were applied to the fully extended legs. The nails and sutures were removed about 3 weeks after operation, and the wounds were completely healed. The patient left the hospital 2 months after operation with legs straight and he walked without crutches.

In April, 1936, 2½ years after operation, there is no evidence of adductor contracture. He no longer walks with adductor spasm or knee flexion. He is, of course, still spastic and a little uncertain, but he can run and play football, whereas before operation he could scarcely walk. The knees can be voluntarily straightened.

In Figure 3, A and B, the patient is shown before operation with knee flexion and adductor contracture. Figure 3, C, D, and E show the patient 2 years later without adductor contracture, and there is no knee flexion deformity present.

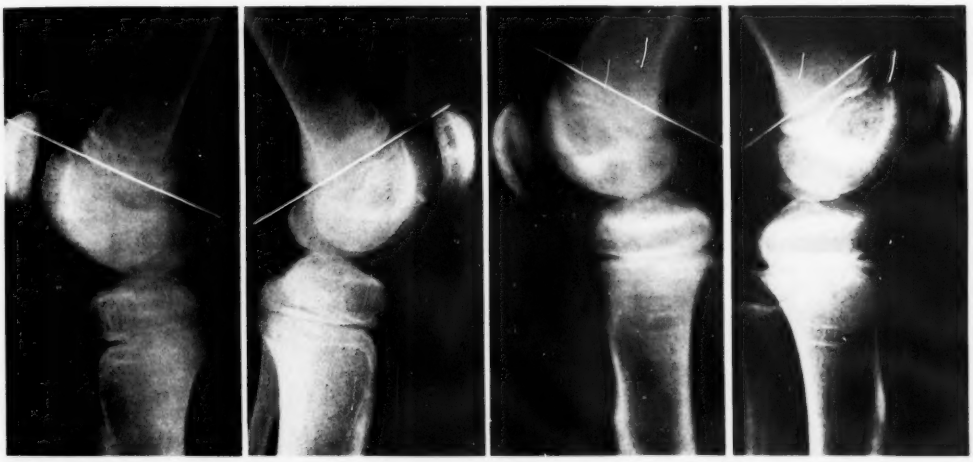
Roentgenograms (Fig. 4) of the right and left knees show the relative positions of the patellæ before operation, A, and after operation, B, in relation to the epiphyseal lines of the femora.

Case 2. J. R., St. L. No. 247509, a boy of 5 years. The patient was admitted to the orthopedic service of St. Luke's Hospital on January 19, 1933, with a spastic tetraplegia. He was unable to walk. Both legs were markedly spastic. His knees were flexed. From his sitting on his flexed and rotated knees, he had developed a marked bowing of both tibiæ with torsion. His knees were flexed 25 to



A B C D E

Fig. 3. Case 1. Photographs before and after operation.



A B

Fig. 4. Case 1.

30 degrees. The knees were stretched, and plaster-of-paris circular splints were applied on January 23, 1933.

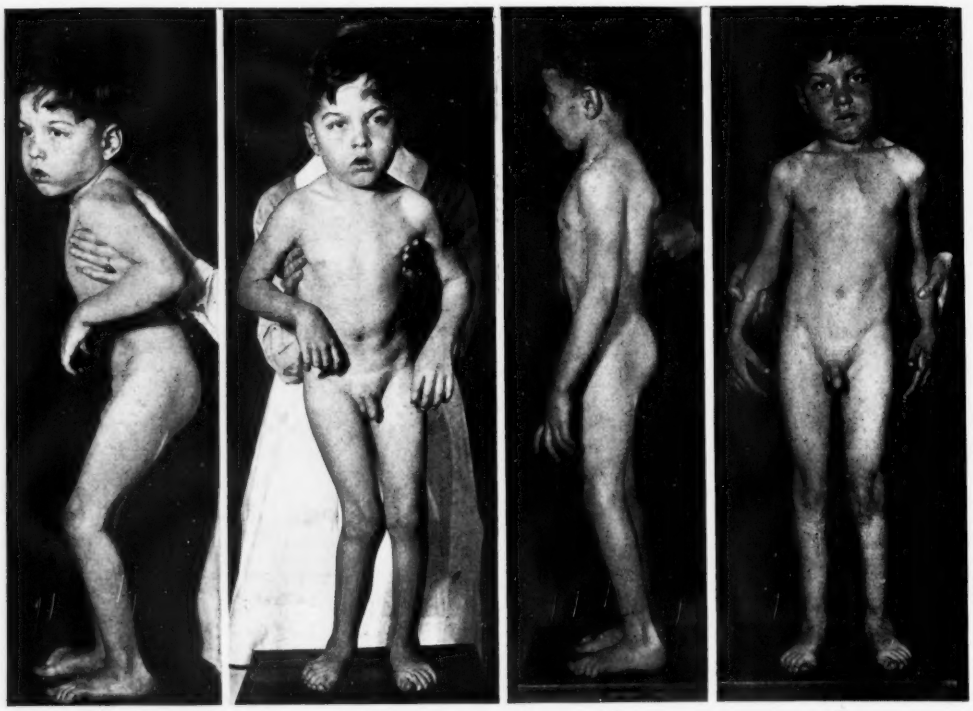
On February 13, 1933, a bilateral tibial osteoclasis was done.

On March 27, 1933, the nerves to the right and left hamstring muscles were injected. Plaster-of-paris splints were applied with the knees fully extended and the legs widely abducted.

His postoperative course was uneventful, and he was discharged in May, 1933. He was attempting to walk with stiff leg braces on both legs, but he was unable to do so without support. He went to the Convalescent Hospital until December, 1933, but his walking was extremely difficult because of his 20 to 30 degrees of knee flexion.

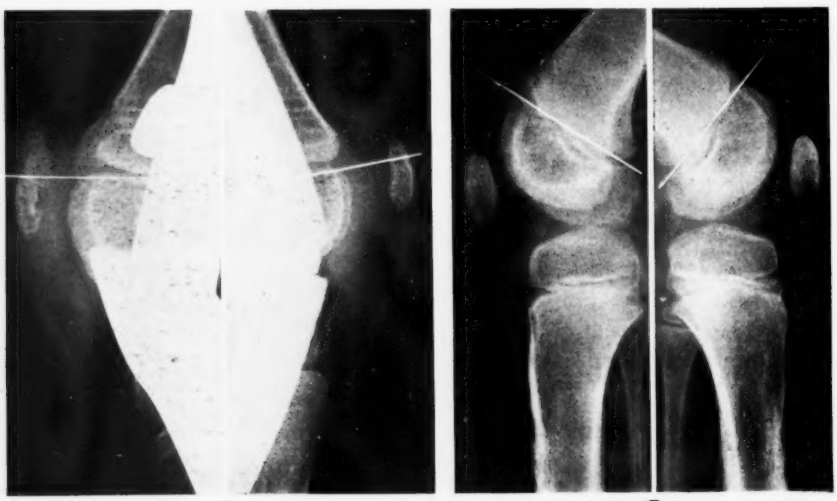
He was readmitted to the St. Luke's orthopedic service January 10, 1934, on account of his knee flexion deformity. There was marked relaxation of both patellar ligaments, and the lower borders of the patellæ were situated an inch or more above the joint line.

On January 15, 1934, a bilateral transplantation of the tibial tubercles was done, a block of bone with the ligamentum patellæ attachment into the tibial shaft being inserted



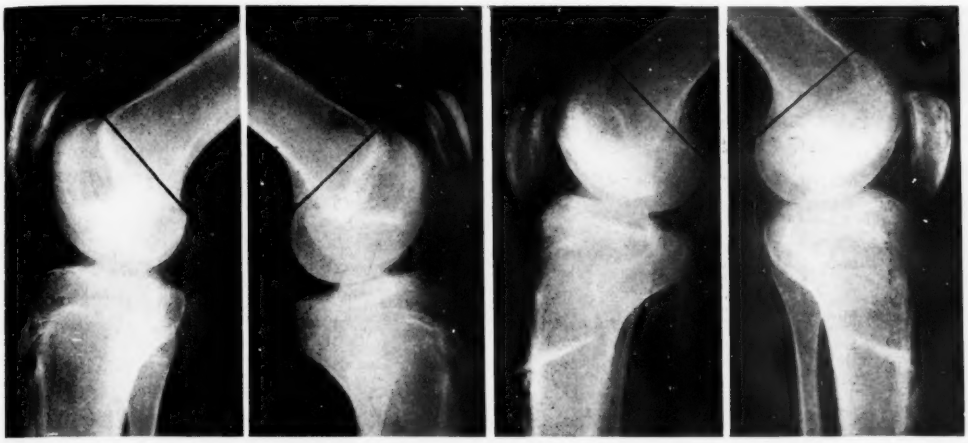
A B C D

Fig. 5. Photographs of patient, Case 2, before and after operation.



A B

Fig. 6. Case 2.



A B

Fig. 7. Case 3.

1 inch distal to its normal site. The block was held in place with silk sutures and a 2 inch wire nail. Plaster-of-paris spica bandages were applied. The nail was removed 2½ weeks after operation, and the plaster splints were removed 6 weeks after operation. It was noted that on discharge from the hospital 2½ months after operation his knees were straight, and he could flex them to 90 degrees.

At his latest follow up examination, 26 months after operation, it was noted that the patient could fully extend his knees. He flexed his knees slightly when walking and was still a marked spastic. The patellæ were level with the joint line. He could not walk alone before operation, and he now walks reasonably well.

In Figure 5, A and B, the patient is shown before operation while C and D show the patient 2 years later after operation. The absence of knee flexion is apparent.

The roentgenograms (Fig. 6) of right and left knees before, A, and after, B, operation show the striking shift distally of the patellæ in relation to the femoral epiphyseal lines. The pre-operative roentgenograms were taken with braces on, which somewhat obscure the bones.

CASE 3. L. DeM., St. L. No. 111–282, a boy 17 years of age. The patient had always walked stiffly with his knees flexed. He had had the hamstring tendons lengthened without benefit. His knee jerks were extremely active, and he showed a bilateral ankle clonus. The knees were held in 20 degrees of flexion while the patient was completely at rest, recumbent. The patellæ lay about 1½ inches above the joint line. When standing, the knee flexion was markedly increased.

He entered St. Luke's Hospital on July 9, 1935. A bilateral tibial tubercle transplant was performed. At this time the modified technique was first used. The tibial tubercles were anchored by driving an autogenous bone peg through the ligamentum patellæ just proximal to the block of bone, and the periosteum of the transposed fragment was sutured to the adjacent periosteum with silk.

The wounds healed uneventfully, and the patient wore straight circular plaster-of-paris splints for 7 weeks, and then he wore braces until November 8, 1935, 17 weeks after operation. Ten months after operation, his knees showed full active extension and no flexion contracture. His walking and his stance were greatly improved.

Roentgenograms (Fig. 7) before operation, A, and after operation, B, show the distal shift of the right and left patellæ incident to the transplant of tibial tubercles. The roentgenograms which were taken after operation was performed show the actual distance which the tubercles were transplanted and also the autogenous bone pegs *in situ*.

CASE 4. V. B., St. V. Hosp., a boy 15 years of age. A few days after birth it was noticed that the patient had nystagmus, a cephalic cry, and spasticity of the legs and arms. As he grew older, he had marked deformity of both legs, especially the left, making it very difficult to move about. He became exhausted after walking a few minutes and was compelled to sit down and rest before resuming locomotion again. His mentality was not impaired—there is no history of any hereditary or neurological disease in the family.

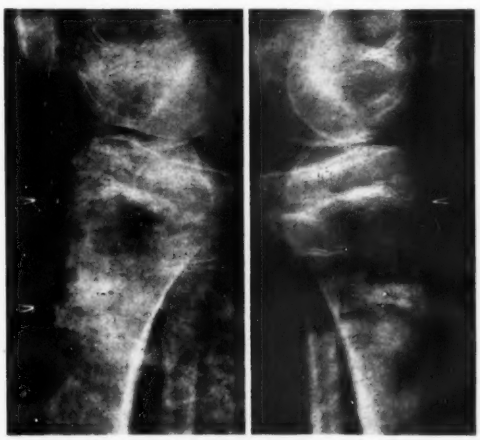


Fig. 8. Case 4.

A B

Fig. 9. Case 5.

Physical examination was negative for heart, kidney, or abdominal disease, but he had a slight exophthalmos. Laboratory tests were practically normal.

He was first seen in the orthopedic clinic April 26, 1935, with a diagnosis of spastic tetraplegia. On examination he had 65 degrees of flexion deformity of the knees, 35 degrees of hip flexion, the patellæ were high, and left talipes equinus with varus.

He was admitted to the hospital, and on May 1, 1935, he had a left subastragaloid arthrodesis with a cast from toes to the midthigh.

On May 15, 1935, a posterior capsulotomy was done on both knees for the flexion deformity. Long plaster boots were applied. On May 29 the casts were changed. The left foot showed slight maceration. New straight leg boots were applied with the knees at 178 degrees. On June 14 he was discharged from the hospital to return later for more work.

On July 12, 1935, he was readmitted for transplantation of the tibial tubercles. The tibial tubercles were transplanted 1½ inches distally on the tibial shaft, and held in place with bone pegs and black silk. Long plaster boots were applied. On August 3, 1935, he was discharged to return to the clinic in September.

On September 20, 1935, the casts were removed, and the patient was permitted to walk with crutches. On October 25 he was walking with his knees straight.

The latest examination, 9 months after operation, shows no knee flexion deformity. The patient is greatly improved in standing and walking.

Roentgenograms (Fig. 8) immediately after operation, taken through plaster circular splints, show the tibial tubercles have been transplanted approximately 1½ inches distally. The autogenous bone pegs can be seen.

Case 5. E. L., S. Hosp., a girl 10 years of age. This patient was first seen on May 29, 1935. Her mentality was distinctly subnormal. This is the only child in the series with impaired mentality. She had spastic paraplegia, lower extremities were badly involved with 20 degrees of knee flexion deformity. She had marked calcaneovalgus deformities of both feet. The child had never walked or stood.

On July 19, 1935, a right and left subastragaloid arthrodesis was done at Seaside Hospital. On August 8, 1935, a tibial tubercle transplant was done. All casts were off September 21, 1935.

On October 14, 1935, she could stand hanging on to a support, and on that date she could fully and actively extend both knees and flex them to 90 degrees. The subastragaloid arthrodeses were solid and in stable position.

On March 4, 1936, patient was able to walk a few steps with someone holding on to her hands. She could fully flex and extend both knees. There is every reason to believe that this patient will learn to walk unaided as did patient in Case 2.

Roentgenograms (Fig. 9) show the distal shift of the right and left patellæ accomplished by the transplantation of the tibial tubercles. The autogenous bone pegs can be seen *in situ* in the roentgenograms which were taken following operation, B.

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FEMORAL HERNIA

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THE operations for repair of femoral hernia are innumerable. Technique in this country has in the main crystallized into two types with slight variations: that of the femoral approach or the Bassini operation, and the inguinal approach following the technique of Moschcowitz (4, 5). The technique of Lotheissen (2, 3), sound as it is in principle, has not been widely adopted. The majority of writers on the subject consider femoral hernia a simple surgical problem with the operative repair completely and satisfactorily worked out by either of these standardized procedures and with the recurrence rate very low. A smaller group believe that the recurrence rate in femoral hernia is higher than statistical studies indicate because of the difficulty in tracing cases after operation, and that present operations in common use throughout this country are not anatomically sound and violate good surgical principles. Dowden states: "Almost every surgeon will agree that the radical operation for the so called cure of femoral hernia is unsatisfactory. Recurrence is humiliating and not at all uncommon." Recurrences have been stated by various authors at rates of from 4 to 30 per cent. Extremely low figures are probably incorrect because of the difficulty of following cases after operation.

This paper attempts to emphasize some of the important principles stated by previous writers and to apply these to a practical and successful operative technique.

Of first importance is the principle that any form of hernial closure that ignores the fascial structures of the abdominal wall is unsound. This holds true of any hernia whether it is epigastric, umbilical, postoperative, inguinal, or femoral. The endo-abdominal fascia is essential to the integrity of the abdominal wall, and any breach in the wall must first pass this fascia before becoming a hernia. An indirect inguinal hernia does not become such, no matter how long a preformed sac has remained dormant, until the internal ring, which is an opening through the transversalis or endo-abdominal fascia, becomes dilated. A direct inguinal hernia is a relaxation of this fascia. In a femoral hernia the transversalis fascia and iliac fascia are separated, and the fascial layer connecting them at the inner end of the femoral canal, or crural septum, is pushed ahead of the advancing sac. The overlying muscles are of great importance; but any repair that is chiefly concerned with muscular structures, or structures at a distance from the abdominal cavity, is unsound.

Another fact is frequently ignored. The femoral ring has rigid, inelastic walls. Poupart's ligament cannot be so securely sutured to either the pectineal fascia, or Cooper's ligament, that it will not frequently pull off and reopen the femoral canal. This ligament is stretched like a string across a bow, with heavy abdominal muscles attached to its upper surface which tend constantly to restore it to its normal position. The futility of such procedures is demonstrated in the many early operations in which silver wire, staples, bone pegs, etc., were resorted to in attempts to fasten down permanently the inguinal ligament to the underlying structures. The problem must be attacked in a different way. Normally there is no femoral canal, the femoral vein lying in close proximity in Gimbernat's ligament. This space is opened up by an advancing hernia, pushing the femoral vein laterally. When the hernia is properly repaired it cannot enter this artificial canal and the femoral vein again fills up the space.

A strong objection to operations attacking the femoral canal, especially by the crural approach, is that they close the lower end of a funnel leaving the funnel in place. This permits the force of intra-abdominal pressure again to exert its expanding pressure, and with the aid of muscular traction on Poupart's ligament, has a constant tendency to reopen the canal. A proper closure, as in all other hernias, should be flush with the abdominal cavity in order to diffuse this pressure. A relatively weak closure at this point is more successful than a strong closure at a distance. This point cannot be too strongly emphasized.

As anatomical facts have been better understood, operations for femoral hernia have been progressing upward. The crural approach has been decreasing in popularity and the inguinal operation more universally adopted. Closure of the femoral canal from above permits a higher ligation of the sac, but if this alone is done the repair is far from ideal. The primary defect in the endo-abdominal fascia is ignored, and all attention directed to the femoral canal as it passes beneath Poupart's ligament. As a consequence the fundamental weakness still persists and is the cause of recurrence of the femoral hernia, or it possibly shows up as a direct inguinal hernia. This

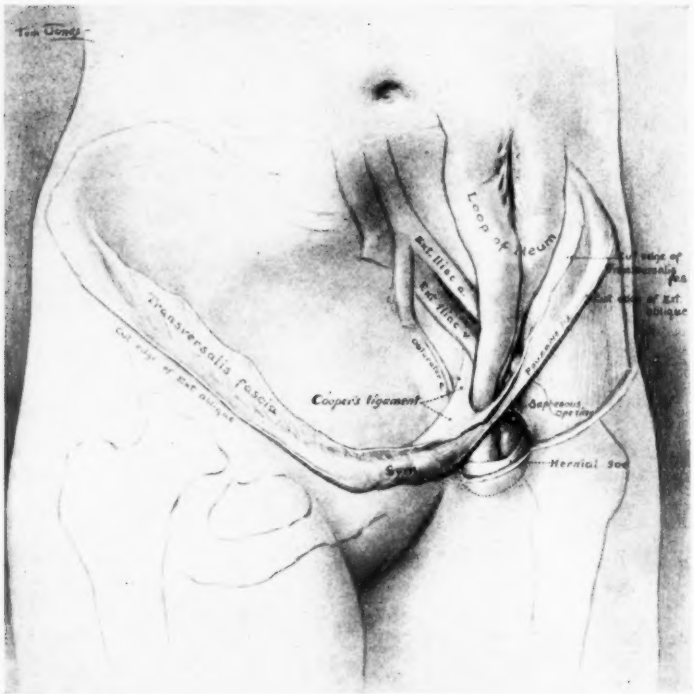

Fig. 1. Dissection of female pelvis to show the structures forming the femoral ring. The pelvis is tilted slightly forward and is viewed slightly from the right side. (Courtesy of Seelig and Tuholske.)

defect, if searched for, can be easily demonstrated, the gap through this fascia into the abdominal cavity often admitting three fingers. The purpose of this paper is to emphasize the importance of this gap in the endo-abdominal fascia and to carry the operation a step farther upward to repair this defect.

Of all the operations previously proposed for the closure of femoral hernia, the Lotheissen technique comes the nearest to fulfilling the requirements of the anatomical and surgical principles involved. He recognized the importance of closing this breach in the endo-abdominal or transversalis fascia and accomplished this by suturing the entire conjoined tendon to Cooper's ligament. The chief objection to this method is the constant muscular pull on the suture line which may jeopardize its success.

The operation herein proposed is a modification of the Lotheissen technique. Instead of using the entire conjoined tendon, it uses only the transversalis fascia. The transversalis fascia is the inguinal portion of the endo-abdominal fascia, which supports the entire abdominal cavity. It is a strong fascial layer lying superficial to the peritoneum and separated from it by loose areolar tissue. It is the fascial component of the conjoined tendon, lying deep to the internal oblique muscle. It forms the floor of the inguinal canal and passes on to the thigh beneath Poupart's ligament to which it is attached. It there merges into the fascia lata. The transversalis fascia is the natural structure to use in the repair of a hernia, for it is the loss of integrity of this structure that permits the egress of a hernia from the abdominal cavity. If this fascia is properly exposed, it will be found to be a strong structure, easily mobilized, and readily sutured to Cooper's ligament. If it unites properly, there is interposed between the abdominal cavity and the femoral canal a strong layer of fascia which successfully prevents the re-entrance of abdominal contents into this canal. It is not subject to the objections and defects that are inherent in a hernial repair in

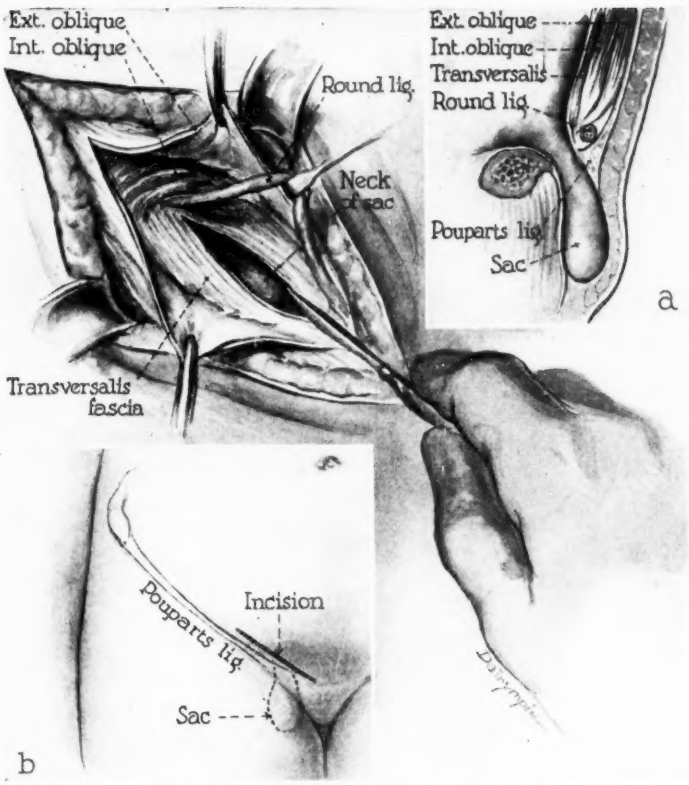

Fig. 2. The external oblique fascia has been incised and retracted. Incision is being made in the attenuated transversalis fascia which forms the floor of the inguinal canal, exposing the neck of the sac. Insets show femoral hernia in cross section and position of incision.

which muscle is used. There is much better relaxation of the suture line during healing, which means a stronger and more solid union; also less muscular pull on the line of attachment to Cooper's ligament and less danger of attenuation. The treatment of the femoral canal is of minor importance and perhaps is best left unsutured.

The anatomy of femoral hernia will not be given in detail. An excellent description of Cooper's ligament is given by Seelig and Tuholske who also describe the inguinal operation of Moschcowitz. An illustration from the article of Seelig and Tuholske is reproduced as it gives a very clear view of the principal structures concerned in the repair of femoral hernia. Cooper's ligament is clearly shown overlying and covering the horizontal ramus of the pubis.

TECHNIQUE

The technique down to the removal of the sac is similar to either the Lotheissen or the Moschcowitz operation. The skin incision is made parallel to Poupart's ligament and about one-fourth inch above, the lower end being over the pubic bone.

The external oblique fascia is divided, thus opening up the inguinal canal. The cord or the round ligament is retracted upward and should be cleanly dissected from the canal. This can best be done by wiping, with gauze over the finger, beginning on the inner side of Poupart's ligament near the pubic bone and following down the fascia to the floor of the inguinal canal. None of the cord structures should be left attached to the fascial floor. A finger is passed around the cord

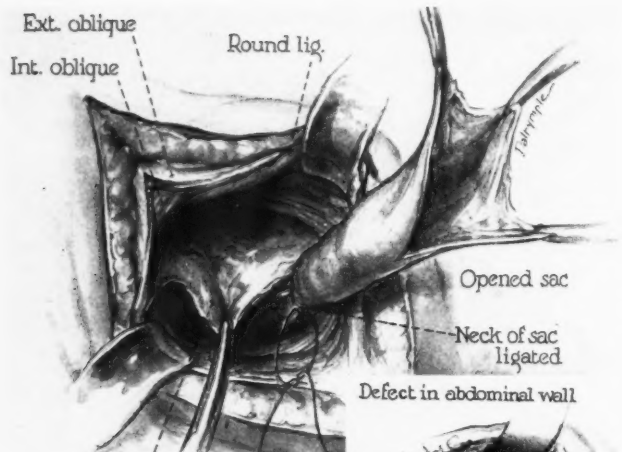

Fig. 3.

Fig. 3. The sac has been delivered and the neck ligated. The transversalis fascia has been drawn down and freed from the overlying muscular portion of the conjoined tendon. Inset shows the defect in the abdominal wall after removal of the sac.

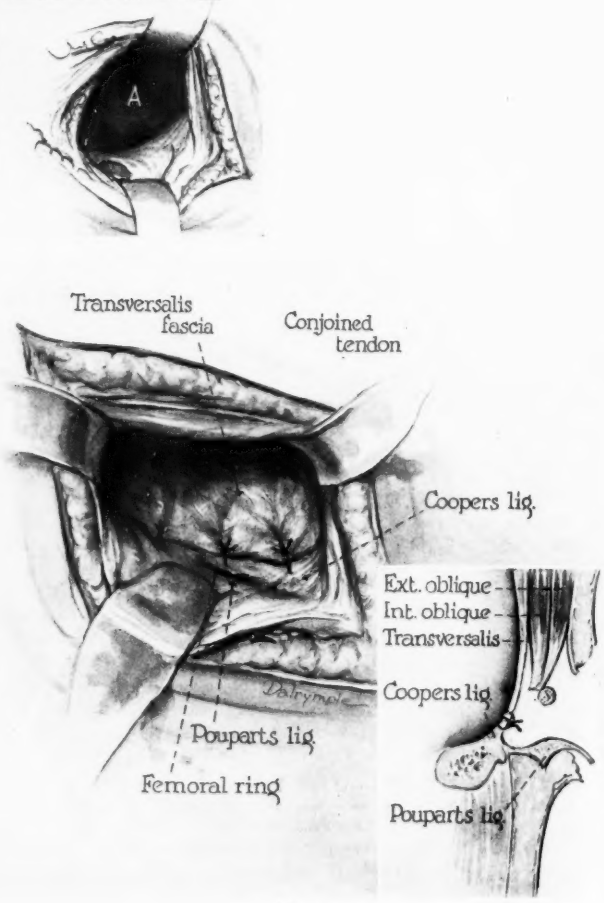

Fig. 4.

Fig. 4. The transversalis fascia has been sutured to Cooper's ligament. The femoral vessels lie lateral to the outer stitch. Inset shows closure in cross section.

from behind and below, and it is then retracted upward, thus exposing the floor of the canal (Fig. 1).

The floor of the canal is then incised parallel with Poupart's ligament, this incision being made through the transversalis fascia exposing the neck of the hernial sac (Fig. 2). The neck is then separated from its attachments by passing a finger beneath it, the sac is entirely freed by blunt dissection and drawn up into the inguinal canal. If necessary the contents of the sac may first be reduced by an incision into the neck, and the contained omentum or loop of bowel withdrawn and inspected and then replaced in the abdominal cavity. The neck of the sac is crushed with forceps, ligated high with a suture ligature, and the sac is excised at as high a level as possible—an important point.

The defect into the abdominal cavity will be found upon examination. At this point the proposed technique diverges from that of Lotheissen. The transversalis fascia can easily be identified by retracting the internal oblique muscle upward (Fig. 3), where it is seen as a strong sheet of white fascia applied to the inner surface of the internal oblique muscle and fascia. By placing forceps on its margin, it can be drawn down and mobilized sufficiently to be easily approximated to Cooper's ligament, where it is sutured usually with three interrupted chromic catgut sutures, the outermost suture being as near the femoral vein as is practicable (Fig. 4). The objection has been raised that this leaves a defect so that a hernia can again pass between the outer margin of this fascia and the femoral vessels; but this is unlikely, as a hernia passing out with the femoral vessels is extremely rare.

The femoral canal can now be closed by suturing the posterior margin of Poupart's ligament to the pectineal fascia as in the Moschcowitz operation. It is possible to leave out this step entirely without jeopardizing the result.

It is well at this point to examine the internal inguinal ring and, if enlarged, to narrow it with one or two sutures. Otherwise no attempt is made to imbricate the inguinal canal. The cord is dropped back in place, and the external oblique is sutured. The superficial fascia and the skin may be closed in any manner desired (Fig. 5).

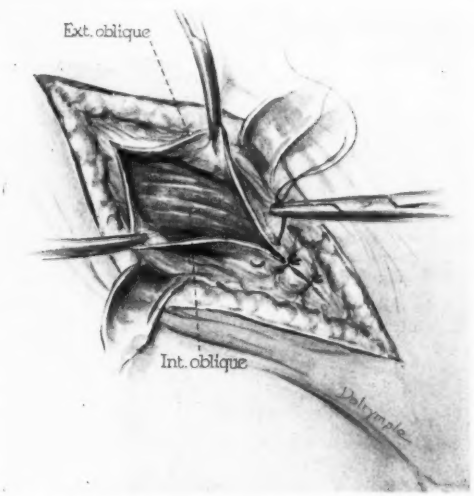

Fig. 5. Superficial structures are sutured in their original position. Cord is not transplanted.

ADVANTAGES

One advantage of this plan of operation is that it repairs the defect at its source, using the normal anatomical structures through which the hernia first passes out of the abdominal cavity. The transversalis fascia can be easily mobilized and sutured without tension. This effectively blocks off the upper end of the femoral canal with a strong fascial structure which permanently prevents the re-entrance of a protrusion from the abdominal cavity. Thus the repair is entirely independent of the notorious uncertainty of permanently approximating Poupart's ligament to the pectineal fascia.

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INTUSSUSCEPTION IN ADULTS

Two Additional Cases

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SINCE the classical analysis of 300 cases of intussusception in adults by Eliot and Corscaden in 1911, numerous valuable contributions have been published. Good general discussions of the subject have been written by Hubner, Leclerc, Starlinger, and others. Mooro reported 2 cases of acute ileocolic intussusception in adults due to fasting. Moreton reported a case of intussusception in a 24 year old patient with typhoid and collected 10 other cases from the literature. Five of the 6 patients operated upon in Moreton's series recovered and 4 of the 5 not operated upon died. Meckel's diverticulum as a cause of intussusception in adults was reported by MacDonald (1 case) and Drummond (2 cases). Harkins analyzed 160 cases of intussusception of all ages due to Meckel's diverticulum. In Perrin and Lindsay's study of 400 cases of acute intussusception 18 patients were over 14 years of age. Intussusception into a gastro-enterostomy stoma has been reported by Lewisohn, Sibley, Darling, Schilling, Shearer and Pickford, Bettman and Baldwin, and Adams. The roentgen-ray diagnosis of intussusception is presented by Sussman and the treatment by transileal resection of the intussusception is discussed by Delore and de Girardier. Pryde and Moreton have reported cases in which there was recovery following spontaneous passage of the intussusception without operation. In 1921 Kingsford reported a case of intussusception in an adult in which the ileum was anastomosed to the transverse colon because the intussusception was irreducible. The entire necrotic intussusception was passed 10 days after the operation and the patient recovered. The value of short circuiting an irreducible intussusception by local anastomosis has been well established by Montgomery and Mussil who reported 2 successful cases in children and confirmation by experiments with dogs. Twenty-five cases of intussusception in adults have been reported in which no tumor was found or at least described.

Eliot and Corscaden found that of 300 cases of intussusception in adults, 100 (33⅓ per cent) were due to a tumor. Of these tumors 60 per cent were benign and 40 per cent were malignant. They found that the benign tumors generally originated in the inner layers of the intestinal wall and usually had constricted or pedunculated bases. Polyps occurred most frequently and were occasionally multiple. Other benign tumors described by Eliot and Corscaden were lipoma, myo-adenoma, fibroma, myxofibroma, myofibroma, myxoma, papilloma, and cyst of the ileocecal value. In 1912 Kasemeyer analyzed 208 cases of intussusception due to tumor and found 55 to 75 per cent of the tumors were benign.

Since Eliot and Corscaden's paper there have been 43 case reports of intussusception in adults due to benign tumors. Nine of these were described as adenomas, 5 as polyps, 2 as papillomas. In addition to these 16 cases of epithelial type of benign tumor, the case of Benjamin is of interest. In this case, a male of 39 years, there was an intussusception in the upper part of the jejunum beginning about 8 inches from the ligament of Treitz. A cauliflower-like tumor 3 by 4 by 3 centimeters projected into the lumen of the bowel. It proved to be an adenoma of an accessory pancreas. Eleven cases of lipoma causing adult intussusception were found. Stettin found intussusception to have occurred in 60 per cent of 67 cases of intestinal lipomas. Nine cases of fibroma have been reported, 1 of which involved the appendix. Clifton and Landry collected 45 cases of fibroma of the intestine and found intussusception in 33 of them. There were two myxomas, a leiomyoma, and a carcinoid. Theis reported an ileocecal enterocystoma (a type of mesenteric cyst) which produced a partial intussusception. In the interesting case of Steiger's, there was an accessory pancreas in a diverticulum of the lower ileum which caused a subacute intussusception.

Since Eliot and Corscaden's paper there have been 16 cases of intussusception in adults due to malignant tumors. Of these 10 were carcinoma and 6 were sarcoma. Eliot and Corscaden, in addition to carcinoma and sarcoma, found a melanotic epithelioma.

Most of the cases of intussusception in adults are characterized by the symptoms of acute intestinal obstruction although there have been cases with previous attacks of obstruction which subsided without operation, cases characterized by more or less chronic pain and vomiting, and

Fig. 1. Photograph of longitudinal section of specimen of jejunal intussusception. Note papillary adenoma at the right. Compare photograph with drawing (Fig. 2.).

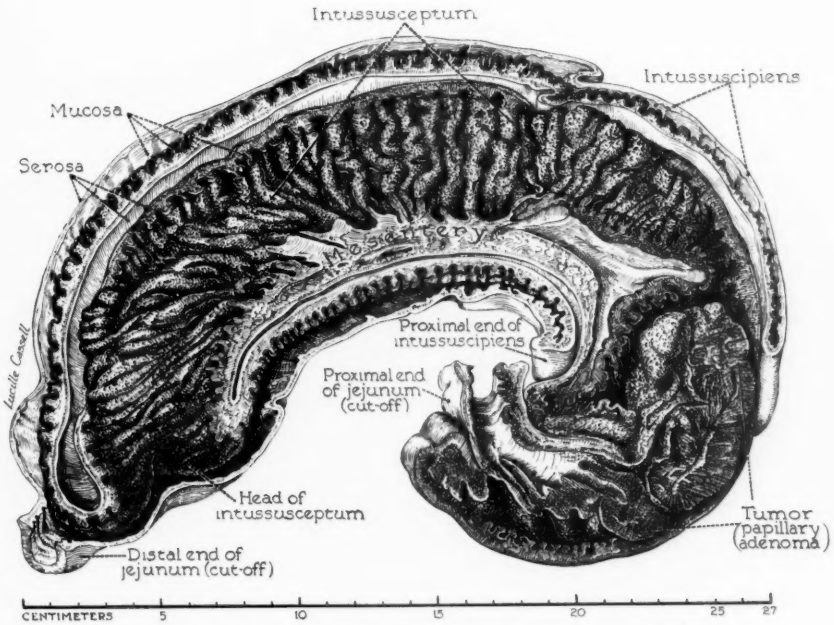

Fig. 2. Drawing of specimen of jejunal intussusception. Compare with Figure 1.

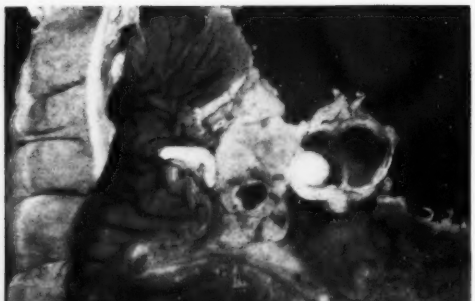

Fig. 3. Chronic ileocolic intussusception in an adult. Note invagination of the terminal ileum into the cecum.

cases which have simulated other lesions such as cholecystitis or peptic ulcer. The writer wishes to report 2 additional cases of intussusception in adults.

CASE 1. *High jejunal intussusception caused by a papillary adenoma.*

Patient E. T. L., age 22 years, was admitted to the Evanston Hospital on January 4, 1936. His past history was of interest. For the past 2 years his weight was unchanged although he had had a ravenous appetite. About half of the time he felt uncomfortably full after meals and was troubled by "gas in the stomach" and belching after meals. During this time he often had "gas pains" while eating; a bowel movement relieved this condition and would permit him to resume his meal. The abdominal pains have become more frequent in the last 6 months and especially during the last month. The pains were often relieved by enemas.

The patient was awakened early on the day before admission by pain in the abdomen which soon became so severe that a doctor was called who administered ¼ grain of morphine hypodermatically. Nausea and vomiting were present intermittently. Enemas given several times Friday were returned in each instance with gross bright red and dark red blood. The physical examination revealed a thin white male who seemed most comfortable lying on his back. Save for the abdomen the general examination was negative. The abdomen presented a firm, sausage shaped mass extending transversely across the abdomen and seeming to have a diameter of about 5 inches. The abdomen was not particularly rigid. The patient was quite dehydrated. The temperature was 99.2 degrees, the pulse 106, and the respirations 22. The leucocyte count was 9,350, the erythrocyte count, 3,060,000; the hemoglobin, 60 per cent; and the urine was negative except for an occasional granular cast.

The patient was given subcutaneous fluids and immediately laparotomy with the diagnosis of intussusception or volvulus was carried out.

When the abdomen was opened enormous high jejunal intussusception presented a startling appearance. It was necessary to make a long left rectus incision and supplement it by a 5 inch lateral incision through the obliques to the left. The large sausage shaped mass was curved to almost a complete circle and was about 5 inches in diameter. It seemed to be attached by a twisted pedicle, but efforts to reduce it by detorsion were futile and it soon became apparent that we were dealing with a large intussusception situated about 6 inches below the ligament of Treitz. Efforts to reduce the intussusception were fruitless even after aspiration of a small amount of fluid from the bowel itself. Accordingly the entire mass was resected and a lateral anastomosis of the jejunum was performed.

Save for a wound infection which healed readily the patient made a satisfactory recovery from this operation.

The report of the pathologist, Dr. F. D. Gunn, is as follows:

"*Gross* (Figs. 1 and 2). The specimen consists of a segment of an enlarged small intestine measuring along the antimesenteric border about 43 centimeters in length. Both ends are constricted and the lumen at each of these two ends measures approximately 1 centimeter in diameter. The outside serosal surface shows mild diffuse hyperemia, injection of the small serosal vessels and scanty deposits of fibrin threads and granules. A sagittal section after previous fixation reveals three layers of intestinal wall. At the proximal end, i.e. the end through which the stump of the mesentery projects, the inside segment contains a large papillary tumor measuring 9 by 5 by 5 centimeters which itself is intimately attached by a fibrous pedicle about 3 centimeters in diameter to the proximal end of the mesentery. The lobated surface is discolored by diffuse brown hemorrhage and shows fine, closely set papillæ. In sagittal section the tumor is found to contain a branching fibrous stalk and core to which the intensely hemorrhagic papillary structure is attached. The attachment of this tumor is located approximately 6 centimeters from the proximal end of the specimen. It closely fills about one-third of the inner segment of intestine, the mucosa of which is greatly thickened and hemorrhagic. Much of it is covered by brown and gray exudate. When this is followed to the distal end of the specimen, the inner segment is found to be continuous with a second layer which is inverted. The mucosa and submucosa of this second intermediate layer show more marked edema than the inner layer and the plicæ semilunares are greatly swollen, packed tightly together, and covered by diffusely hemorrhagic, finely granular mucous membrane. A small amount of granular fibrinous exudate is superimposed upon this everted surface. The intermediate layer is continuous at the proximal end of the specimen with the outermost layer (intussuscipiens). The latter is dilated to a maximal circumference of 24 centimeters. The wall is thin, the plicæ are flattened and the mucosa shows only a small quantity of blood-tinged fibrinous exudate.

"*Microscopic diagnosis.* Necrotic, hemorrhagic, papillary adenoma of the jejunum."

After some 2 weeks of convalescence it was observed that the patient was not progressing as well as was expected. Blood was found in the stool on eight examinations. Further roentgen-ray studies of the bowel were carried out on February 12 and February 17. These examinations suggested very strongly the presence of polypoid tumors in the cecum and distal half of the transverse colon. On February 26, 1936, the patient underwent a second operation. The anastomosis done at the first operation was found to be

firm and clean. The entire jejunum and ileum were carefully palpated but no tumors were discovered. In the cecum, however, a golf ball sized tumor was easily felt. Palpation of the colon indicated a small tumor in the right half of the transverse colon and numerous small tumors in the left half. Feeling that the patient might well have a multiple polyposis, and that it might be necessary ultimately to resect the entire colon, an ileocolostomy to the transverse colon was carried out and the right half of the colon together with the cecum and a few inches of the terminal ileum were resected at one stage. The pathologist (Dr. F. D. Gunn) reported a pedunculated adenoma of the cecum. The suspected small tumor of the right half of the colon proved to be fecal material, a finding which threw considerable doubt upon the suspected presence of small tumors in the left half of the colon.

The patient made a satisfactory recovery from the second operation. Repeated examinations of the stools failed to disclose blood. On March 7, 1936, the hemoglobin was 85 per cent and the red blood count was 5,110,000. On March 22, 1936, the wound was practically healed and as the patient walked about easily he was discharged from the hospital.

A proctoscopic and sigmoidoscopic examination was done by Dr. W. Kenneth Jennings on March 31, 1936. The sigmoidoscope was passed for a distance of 22 centimeters. The rectum and sigmoid were entirely normal.

CASE 2. *Chronic ileo-cecal intussusception.*

Patient K. P. U., female, aged 40 years, was admitted to the Evanston Hospital on March 19, 1931. For about a year the patient had noticed a mass in the right lower quadrant which was unproductive of symptoms until about 6 weeks previously when she began to experience vomiting, abdominal cramps, and malaise. Five days previous to admission the mass became painful and the cramp-like pains more severe. There had been no constipation, bloody stools or loss of weight. There had been a history of moderate cardiac decompensation. The patient is well nourished and the physical examination was essentially negative save for a large, elliptical, tender, movable mass in the right lower quadrant. Repeated examinations of the stools failed to reveal occult blood. Roentgen-ray examination (Dr. James T. Case) revealed an organic lesion of the cecum which had "the ear marks of carcinoma." The blood Wassermann was negative.

On March 25, 1931, exploratory laparotomy was carried out under nitrous oxide gas and ether. A mass the size of a baseball was found, which involved the cecum and the adjacent ileum. It extended about 4 inches in each direction from the ileocecal valve. In the mesentery of the ileum and cecum in this region were numerous hard lymph nodes ranging from 2 centimeters in diameter near the bowel to smaller sizes as the mesentery was followed up toward the pancreas and duodenum. A diagnosis of carcinoma with metastases to the lymph nodes was made and a radical resection was carried out. The cecum, ascending colon, proximal half of the transverse colon, and 12 to 14 inches of the ileum were removed in one block. A lateral anastomosis between the ileum and transverse colon was then performed and the rent in the mesentery was sutured. Omentum was applied to the anastomosis and a Witzel enterostomy was done 7 inches proximal to the resection. The enterostomy tube was carried out through a stab wound in the right lower quadrant and the wound was closed without drainage.

The pathological report (Dr. Francis D. Gunn) of the excised specimen is as follows:

"*Gross* (Fig. 3). This specimen consists of about 40 centimeters of small intestine (lower segment of ileum), the cecum, ileocecal valve, and approximately 22 centimeters of ascending colon measured from the ileocecal valve. The wall of the lower 10 centimeters of the ileum is thickened and indurated. The distal 4 centimeters of the ileum protrudes into the lumen of the cecum. This portion will barely admit the tip of the small finger. This intussuscepted segment shows purplish discoloration, induration, and there is an excessive quantity of mucus in its lumen. The mucous membrane of the cecum shows a high grade of edema.

"Peritoneal surface in the region of the ileocecal valve is rough, granular, and spotted with purplish hemorrhages. The mesentery is thickened, edematous, hemorrhagic, and contains several enlarged soft hemorrhagic lymph nodes. Several soft lymph nodes with prominent follicles are included separately.

"A sheet of fibrous connective tissue with fat resembling omentum is included separately. Sections are taken from the ileocecal value in the center of the indurated mass, from the wall of the cecum, and from the mesenteric lymph nodes.

"*Microscopic.* Sections taken from different parts of the indurated mass at the ileocecal valve show evidence of chronic inflammation in the form of edema, numerous large foci of lymphocytic, plasma cells and eosinophil infiltration, interstitial hemorrhage, and proliferation of fibroblasts. This infiltrate involves the entire thickness of the muscular wall and extends out into the mesenteric fat.

"There is no evidence of malignancy in the tissue examined.

"Sections from the lymph nodes show high grade follicular hyperplasia, moderate reticulo-endothelial hyperplasia, interstitial hemorrhage, and edema. The pulp shows further evidence of subacute and chronic inflammation in the form of plasma cell, eosinophil and neutrophilic infiltration.

"*Diagnosis.* Chronic intussusception (lower end of ileum into cecum), with chronic inflammation and edema.

"Subacute and chronic hemorrhagic lymphadenitis of the regional lymph nodes."

The postoperative course was extremely stormy and the patient died despite all therapeutic efforts on the third postoperative day.

At postmortem examination, although the anastomosis was found to be water tight an acute generalized fibrinopurulent peritonitis was present. This apparently was due to displacement of the enterostomy tube from the ileum permitting the escape of intestinal contents into the peritoneal cavity.

SUMMARY

Two cases of intussusception in adults are reported. One case involved the high jejunum and was caused by a papillary adenoma; the other involved the ileocecal valve and showed no definite cause.

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GENERALIZED PERITONITIS SECONDARY TO RUPTURE OF THE APPENDIX

WITH SPECIAL REFERENCE TO SERUM THERAPY

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DURING recent years interest in appendicitis has been renewed because of statistical reports which indicate an increasing mortality of this disease. Although reports of this type may be misleading, they nevertheless serve a useful purpose in emphasizing the importance of continuing efforts to reduce this excessive mortality. It is now estimated that approximately 20,000 to 25,000 people die each year in the United States of appendicitis. For the most part, these are young and otherwise healthy individuals.

Donaldson said that the death rate from appendicitis in 1928 was 5.6 per 100,000 population higher than it was in 1900. In contrast, Walker found a mortality of 7.8 per cent in a review of more than 16,000 cases of appendicitis collected from the literature during the years 1907 to 1910, and a mortality of 5.3 per cent in 33,000 cases collected during 1927 to 1930. This indicates that the mortality has been reduced although the total number of deaths has increased. Whether appendicitis has become more prevalent or whether it is recognized more frequently as the true cause of a fatal peritonitis is difficult to determine. The fact remains, however, that far too many people die each year of appendicitis.

The responsibility for reducing this mortality of a disease so readily cured before advanced complications develop lies entirely with the medical profession. People should be instructed concerning the possible seriousness of abdominal pain which persists for more than a few hours, and should be warned against the indiscriminate use of laxatives in the presence of abdominal pain. In this connection a law requiring that a warning be placed on all laxatives sold at drug stores, as has been suggested by C. W. Mayo and others, might be of value. That the use of a purge in appendicitis favors rupture and peritonitis has been repeatedly demonstrated. From the point of view of the physician, early diagnosis and early operation are imperative, and every effort should be made to avoid delay. In the initial 72 hours after the onset of the attack, the mortality almost doubles during each 12 hour period that elapses between the onset of symptoms and operation (Keyes). Under ordinary circumstances it appears much safer routinely to remove a subacute appendix than to risk the chance of rupture while hoping that the process will subside under medical management. The risk of appendectomy before rupture has occurred is practically negligible. So called "interval appendectomies" prevent subsequent severe attacks and should be performed when feasible. This does not mean that the diagnosis of appendicitis should be made without care and consideration, but one definite attack of acute appendicitis should be a warning that recurrent attacks are prone to follow.

PATHOLOGY

Although it is approximately 50 years since Fitz first described accurately the pathological changes which occur in acute appendicitis, many questions regarding the pathogenesis, bacteriology, diagnosis, and treatment of this disease remain unsettled. Clinically and pathologically, the significance of Wilkie's differentiation of the two important types of appendicitis has probably not been sufficiently appreciated. Wilkie emphasized the distinction between "acute appendicitis" and "acute appendicular obstruction." The former condition is primarily an inflammation of the wall of the appendix, without initial obstruction of the lumen. This type of appendicitis is usually gradual in onset, less rapid in its course, and less likely to progress to gangrene and rupture than is the obstructive type. In "acute obstructive appendicitis" a closed loop type of obstruction actually exists, and, consequently, the clinical picture is more suggestive of acute intestinal obstruction with bouts of colic-like abdominal pain. At the onset, systemic reaction is usually slight and the temperature and pulse may remain normal until the pathological process is far advanced. Gangrene of the appendix with perforation and peritonitis may occur very rapidly. Obstruction in the appendix may be

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caused by fecaliths, foreign bodies, kinks from fibrous bands, adhesions, and other less common abnormalities. This is the most dangerous form of appendicitis because of its rapid progress and serious sequelæ. It is largely among this group of cases and those in which a purge has been used following the onset of acute symptoms that deaths from appendicitis occur.

For the sake of clarity, in any discussion of appendicitis an accurate definition of terms and grouping of cases are essential. In fact, the lack of a clear understanding of the exact type of appendicitis under consideration accounts for much of the confusion that exists in the literature on this subject and adds to the difficulties of comparing mortality figures and, consequently, the efficacy of various types of treatment. The following types may be recognized: (1) acute suppurative or gangrenous appendicitis without rupture; (2) acute appendicitis with rupture and localized peritonitis; (3) acute appendicitis with rupture and generalized peritonitis; and (4) appendicitis with rupture and the formation of a localized abscess. It is true that each successive type may represent a later stage of the previous type so that a mixed clinical picture may result during the transition period from one type to the next. Under such circumstances it is often difficult to determine the exact extent of the pathologic changes present. It is important that the stage of the disease is recognized as accurately as possible because treatment will vary accordingly. In the present discussion only the cases which belong to group 3, namely, cases of acute appendicitis with rupture and definite evidence of generalized peritonitis, will be considered.

DIAGNOSIS

Clinically, the most frequent diagnostic difficulty in these cases is the determination of whether the peritonitis is localized or generalized. As is well known, the textbook picture of appendicitis, which includes nausea, vomiting, abdominal tenderness and rigidity, and leucocytosis, is not always present before rupture occurs. This should emphasize the importance of early and accurate diagnosis before all the cardinal findings are present, if the undesirable sequelæ of rupture are to be prevented. It seems superfluous to mention that the safest treatment of appendicitis with rupture would have been appendectomy before rupture occurred. In general, the history, elevation of temperature and pulse rate, abdominal signs, and laboratory studies will suggest the extent of peritoneal contamination. Diffuse abdominal tenderness and rigidity, in contrast with tenderness and rigidity localized in the lower right abdominal quadrant, are very suggestive of an extensive peritonitis. Left sided peritoneal puncture, as suggested by Arnheim and Neuhof, might aid in ascertaining the extent of peritonitis, as, if pus is obtained by aspiration of the left side of the abdomen, peritonitis must be generalized. We have not had any experience with this procedure. If the patient is operated on, the diagnosis is usually strengthened by the appearance of the abdominal cavity and the type and amount of peritoneal exudate.

TREATMENT

Opinions vary regarding the proper management of appendicitis with rupture and generalized peritonitis (2, 3, 5, 8, 9, 10, 17). Some advocate immediate operation in all cases and others consider that medical treatment followed by operation is preferable under certain circumstances. It is extremely difficult to evaluate the relative merit of these two plans of procedure by review of the literature. Oftentimes, different types of appendicitis are discussed, certain cases of advanced peritonitis are excluded from the mortality figures, and an accurate statement of the number of deaths that occur in the course of medical management in preparation for a deferred operation is seldom included. This long continued dispute is evidence of the fact that there are advantages and disadvantages associated with both types of treatment. It is beyond the scope of this paper to consider this phase of the subject in detail or to endeavor in any way to settle the problem. We will merely express our views on the matter.

Depending on the findings in the individual case, the experience of the surgeon, and the facilities he has available, treatment may logically vary. In deciding between immediate and delayed operation, it does seem obvious that one should consider the individual patient and not arbitrarily decide that if symptoms have been present for longer than 48 hours immediate surgical intervention is inadvisable. The great variation with which the pathological changes may progress in appendicitis has been repeatedly emphasized, and we have all seen appendices that ruptured within 18 hours after the onset of symptoms, and others which remained unruptured after 3 or 4 days. If operation is delayed, the Ochsner type of treatment should be instituted. It is our practice to place the patient in Fowler's position, to administer nothing by mouth, to administer morphine regularly, and to give fluids intravenously. No enemas are given;

TABLE I.—MORTALITY OF ACUTE APPENDICITIS WITH AND WITHOUT RUPTURE (NO SERUM GIVEN)

Type of case	Cases	Deaths	Mortality, per cent
Group 1: Acute, diffuse, purulent, and gangrenous appendicitis without rupture (Dixon)	437	0*	0
Group 2: Appendicitis with rupture and localized peritonitis	79	1	1.3
Group 3:† Appendicitis with rupture and generalized peritonitis	81	26	32.1
Group 4: Appendicitis with rupture and formation of a localized abscess	61	4	6.5

*One patient died 12 days after operation, from exacerbation of a cerebral condition of long standing. The abdomen was clean.
†Includes all cases in which the diagnosis of appendicitis with rupture and generalized peritonitis was made, even if the patient was moribund at the time of admission. Eight of the patients who died were not operated on.

large, hot abdominal stupes are applied continuously, and continuous transnasal duodenal drainage is employed if vomiting or distention is marked. This type of treatment is carried out with the hope that the generalized peritonitis will resolve into a localized abscess which can subsequently be drained with a low risk to the patient. The patient is thus transformed from Group 3 to Group 4 as shown in Table I.

In general, we favor immediate operation in all cases of appendicitis before rupture has occurred and in certain cases after rupture has occurred. If doubt exists concerning the perforation, immediate operation appears advisable, because if rupture has not taken place peritonitis can then be prevented. If perforation has existed only a few hours, operation is usually performed unless extensive peritonitis seems to be present. Extreme care must be exercised under such circumstances to avoid spreading infection at the time of operation. If it appears that rupture has occurred a number of hours prior to the patient's admission to the hospital, we often consider immediate operation inadvisable. If the signs and symptoms indicate that infection has remained localized, it is evident that the natural defensive mechanisms have thus far prevented diffuse peritoneal involvement, and appropriate medical treatment should favor continued localization. When an abscess has become walled off, it can be drained extraperitoneally, with little danger of disseminating infection. If the patient is first seen when generalized peritonitis obviously exists, medical management, as outlined previously, may be effective in localizing the process; whereas, immediate operation carries a very appreciable risk. Should conservative treatment be instituted for a localized peritonitis that becomes generalized in the course of this treatment, surgical intervention may be advisable.

If operation is performed and peritonitis is present, drainage (with soft rubber drains of the Penrose type, without gauze) should be instituted, and appendectomy may or may not be performed. Removal of the appendix often appears desirable if it is readily accessible. If the cecum is markedly involved in the inflammatory process, the appendiceal stump usually is ligated, treated with carbolic acid and alcohol, but is not inverted. In contrast, if mobilization of the appendix necessitates trauma to the adjacent inflamed structures, it seems preferable not to disturb the appendix at this time but to postpone appendectomy for 2 or 3 months until the acute inflammatory process has entirely subsided. Subsequent appendectomy should not be deferred indefinitely, as repeated rupture may occur.

Many types of treatment, including lavage of the peritoneal cavity with alcohol, ether, water, or various antiseptic solutions, cecostomy, enterostomy, intra-abdominal injections of oxygen, ozone, or other agents, drainage of the thoracic duct, continuous abdominal lavage, and ultraviolet irradiation of the mesentery of the small intestine have been suggested for peritonitis. The value of most of these procedures remains doubtful.

Serum therapy.—The bacteriological approach in the treatment of peritonitis has been extremely difficult because of the nature and large variety of bacteria involved. Unfortunately, these bacteria are not the organisms which form strong exotoxins. Routine bacteriological studies in cases of acute appendicitis usually reveal a mixed type of infection. Aerobic cultures most commonly reveal Escherichia coli, but also disclose streptococci, staphylococci, Pseudomonas aeruginosa, and other organisms. Anaerobic cultures frequently reveal Clostridium welchii, Bacteroides ramosus, Vibrio septicus, and other bacteria (11, 12). Weinberg (33, 35) studied 200 cases of acute appendicitis at the Pasteur Institute and found anaerobic organisms present in 30 per cent of these cases. These organisms were found much more frequently in cases of gangrenous appendicitis. This work has been confirmed in Germany, France, Japan, and this country (11, 12, 15, 20, 26, 28), and some workers have found anaerobic organisms in a much higher

TABLE II.—REPORTS OF VARIOUS AUTHORS CONCERNING SERUM TREATMENT OF APPENDICITIS WITH RUPTURE AND PERITONITIS

Author	Type of case	Serum not used		Serum used	
		Cases	Mortality per cent	Cases	Mortality per cent
Henschen (13)	Appendicitis with rupture	All from 1918 to 1928	13.2	90	7.2
Dick (4)	Appendicitis with rupture and general peritonitis		35.0	51	25.5
Spitzer (27)	Appendicitis with rupture and general peritonitis	20	60.0	36	14.0
Kunz (19)	Appendicitis with rupture and peritonitis	62	25.0	117	13.0
Reichl (25)	Appendicitis with rupture and peritonitis	96	36.4	74	14.8

percentage of cases than observed by Weinberg. Jennings reported the presence of Clostridium welchii within the lumen of the appendix in 90 per cent of cases. Weinberg and others were of the opinion that the presence of anaerobic organisms materially affects the course of the disease and leads to a severe infection and a serious prognosis. The presence of anaerobic organisms does not necessarily imply the presence of gas-forming organisms, as anaerobic organisms which do not form spores usually produce little gas. The theory has been advanced that anaerobic organisms create a more favorable environment for growth of streptococci, Escherichia coli and other aerobic organisms, which are commonly considered the lethal organisms in peritonitis.

On the basis of these observations, Weinberg (31, 32, 34) prepared two serums, and subsequently a third, for use in the treatment of gangrenous appendicitis associated with rupture and peritonitis. He first made a polyvalent antiserum for the anaerobes most commonly found in these cases. He then prepared a colon bacillus serum, and later a so called complimentary serum to combat other organisms such as streptococci, staphylococci, and others. These serums have been used rather extensively in Europe (4, 11, 13, 16, 19, 21, 24, 25, 29), although they have not been used very much in this country (14). Those who have used these serums uniformly report favorable results, with considerable reduction in mortality, as shown in Table II. We started using these serums some time ago (23) for peritonitis secondary to appendicitis, and also in certain other cases of peritonitis. This treatment has been employed only as an adjunct to the regular medical and surgical care of these patients, and has not been used as a substitute for any part of the usual treatment. Although our data at present are insufficient to warrant definite conclusions, from clinical impressions we think that these serums have been of benefit in certain cases. In addition to reducing the mortality, they seem to decrease the incidence of secondary abscess and other complications, to shorten the necessary period of hospitalization, and to reduce the total amount and duration of drainage from the wound.

If operation is not performed immediately following the patient's admission to the hospital, serum is administered and the usual medical treatment is instituted. Subsequent injections of serum are given as indicated. If operation is performed directly following the patient's admission to the hospital, serum may be administered at once or placed in the peritoneal cavity when the latter is opened, or it may be injected intramuscularly, subcutaneously, or intravenously immediately following operation. Prior to administration of serum the patient should be tested for sensitivity by small intracutaneous injections.

To obtain the best results, serum should be administered early and in adequate doses. Experimental and clinical work has demonstrated (22) that serum is most effective if given within 24 hours following the onset of peritonitis. It is of value at a later period but will not revive a moribund patient in the last stages of a generalized peritonitis. We usually give 40 cubic centimeters of the polyvalent anaerobic serum and 30 cubic centimeters each of the colon bacillus serum and complimentary serum as an initial dose, and subsequent amounts as indicated. Cultures are made at the time of operation, and if these reveal any particular organisms in predominance, further administration of serum may be regulated accordingly. One should not hesitate to give large amounts of serum.

MORTALITY

Appendectomy for acute appendicitis prior to rupture has an almost negligible mortality (Table I). Likewise, operation performed soon

TABLE III.—MORTALITY OF GENERALIZED PERITONITIS SECONDARY TO APPENDICITIS WITH RUPTURE (WITH AND WITHOUT THE ADMINISTRATION OF SERUM)

	Medical treatment only			Delayed operation			Immediate operation			All cases		
	Cases	Deaths	Mortality per cent	Cases	Deaths	Mortality per cent	Cases	Deaths	Mortality per cent	Total	Deaths	Mortality per cent
Serum not used	10	8	80	10	3	30	61	15	24.6	81	26	32.1
Serum used	2	1	50	3	0	0	27	5	18.5	32	6	18.7

after rupture gives very satisfactory results in the majority of cases. When generalized peritonitis is present the mortality is distinctly higher. When rupture has occurred sometime previously and a localized abscess has formed, the risk is again lower. It is extremely difficult to interpret and evaluate the significance of statistical reports on mortality of various types of appendicitis. A comparison between the risk of delayed and immediate operative treatment may also be misleading as these two plans of procedure are employed in different types of cases. When the former type of treatment is used, the patient frequently has a generalized peritonitis which in itself carries a high mortality, regardless of what type of treatment is employed. Likewise, one often sees the mortality for "ruptured appendicitis" reported. Such data usually include several types of appendicitis, including localized or generalized peritonitis, or an appendiceal abscess. If the cases in this series were listed in that manner the mortality in the control series (Groups 2, 3, and 4, Table I) would be 14 per cent. Furthermore, patients who succumb to a generalized peritonitis secondary to a rupture of the appendix soon after their admission to the hospital are often excluded in computing the mortality, and only surgical cases are reported. In the present series of cases (Tables I and III), if mortality were reckoned in this manner there would be 23 deaths in 211 cases of "ruptured appendicitis" or a mortality of 10.9 per cent. These various methods of arriving at the mortality of appendicitis are mentioned because of the frequency with which they are used in the literature and the confusion that they may cause. We believe that the most accurate means of reporting mortality of appendicitis is by a careful subdivision of cases into the exact group in which each case belongs, depending on the extent of the pathological process present.

In Table III it may be seen that there were distinctly fewer deaths among the patients treated with Weinberg's serums than there were among the group of patients used as a control series in which serum was not given. Had these serums been used in larger doses in certain instances we believe there might have been even fewer deaths. The many difficulties encountered in determining the efficacy of serum therapy of this type are fully appreciated, and from our limited experience with this type of treatment we do not feel justified in making a definite statement regarding the value of these serums. We are inclined to feel, however, that certain patients have benefited materially from their use.

SUMMARY

The current mortality from appendicitis is excessive. Education of the public and greater acuity in early diagnosis and early operation are important factors in reducing the hazards of this disease. An accurate appreciation of the variations in the rapidity and sequence of the pathological changes that occur in appendicitis is essential to proper diagnosis and treatment. Immediate appendectomy is indicated prior to rupture. Following rupture, immediate operation may or may not be desirable. The serum treatment of peritonitis secondary to rupture of the appendix seems to offer some hope of reducing the mortality from this complication.

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EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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NOVEMBER, 1936

WATER

THE position of that lowly but useful article of diet, water, has changed amazingly in the estimation of the guild of surgeons within the memory of many of us. It is not such a far cry to the day when acting upon what was supposed to be scientific evidence we systematically withheld water not only before operation, for periods running up to 12 or even 18 hours, but routinely after operation for one or even more days. That serious disaster did not regularly follow was perhaps due to the fact that less elaborate and trying surgery was undertaken. When disaster did in fact befall, it was charged off to the inevitable risk of the operation. In the intervening period, the work of fundamental and clinical scientists has shown that such rigor was not only unnecessary, but dangerous. Today, particularly our younger colleagues, talk light-heartedly, in the jargon of the trade, of dehydration, water balance, chloride deficiency, low serum protein, and many other abstractions which sound learned, and are so in fact, if they by chance know how to fit the phrase to the situation. There is, however, a good deal of evidence tending to show that these phrases do not always represent scientific understanding and that attempts to apply them as therapeutic measures are not always to the advantage of the patient. For instance, we hear much of dehydration, but commonly enough in patients in regard to whom there is testimony, but no evidence of the fact. Recent contributions to the literature at least suggest that there is a fashion in the treatment of this condition not unlike that in ladies' hats, which is not only seasonal, but sectional in its distribution.

We are amply supplied with scientific information proving beyond peradventure that the surgical patient must be kept in balance. Thus he must be kept in water balance, in electrolyte balance, and if possible in protein balance. That, in spite of the various satisfactory methods by which water can be administered other than by mouth, these balances are not always maintained is to say the least tolerably obvious. For instance, it is not uncommon to see a situation in which it is apparently assumed that if a sufficient amount of fluid is administered to provide the kidney with an adequate water supply (1000 to 1500 c.cm.), balance will thus be attained. Sight is often lost of the fact that insensible—sometimes called nonsensical—water loss by skin and lung normally amounts to 1000 to 1500 cubic centimeters. Furthermore, sufficient attention is not always paid to water loss of other types, such as vomiting, diarrhea, and excessive sweating. We have overlooked oftentimes the fact that the water loss sustained

during surgical operations is not inconsiderable. Coller and Maddock have clearly shown that the average water loss in any considerable operation is about 1000 cubic centimeters. Too often, also, we overlook the actual loss of blood, and unless one is faced by the actual evidence, it is common to assume that very little blood is spilled, when as a matter of fact, 1000 or even 1500 cubic centimeters may have gone to the wash. Roughly and generally speaking, the daily normal water loss is 800 to 3000 cubic centimeters of urine, 200 cubic centimeters in stool, and 1000 to 1500 cubic centimeters of insensible loss. To this must be added the abnormal items above enumerated. Coller and Maddock estimate that the average patient should receive at least 2500 cubic centimeters of water during the 24 hours following operation. Subsequent to that time he should receive in the neighborhood of 2000 cubic centimeters, assuming that there is no abnormal water loss.

The maintenance of electrolyte balance requires chiefly the supply of sodium chloride to the amount of about 5 or 6 grams a day. Now in our attempts to maintain water balance, it is not uncommon to see the routine intravenous administration of normal salt solution, often in amounts up to 2000 or 3000 cubic centimeters a day and maintained over a considerable period. This obviously supplies the patient with an amount of sodium chloride enormously in excess of his requirement and if persisted in will successfully achieve the development of edema. In this dilemma recourse has been had to another isotonic solution, 5 per cent glucose, but since this is commonly administered in normal salt solution or in Ringer's solution, the overload remains substantially the same. Such light-hearted administration of fluids may be thought to savour of carelessness, but it does in fact commonly occur. In the same connection we have overlooked the fact familiar to all physiologists that water administered by mouth is a powerful diuretic, whereas water administered subcutaneously or intravenously is not.

Since the days referred to in the opening paragraph when we were largely without methods of supplying water except by mouth, the experts have again come to our assistance. They have shown us that the administration of water by rectum is an unsatisfactory method of supplying fluids. They have shown us that water in almost unbelievable quantities, if given in isotonic solution, may be introduced into the body by the subcutaneous route, quite without discomfort to the patient. One notes, however, that the teachings of Woodyatt that the use of multiple small caliber needles would successfully introduce large quantities of salt solution or 5 per cent glucose without discomfort to the patient have been largely overlooked. The surgeon still shies at subcutaneous administration because he associates it with puncture by large needles, distention of the tissues, and pain. These are characteristic of faulty method and should not be charged against the subcutaneous route in maintaining water balance. The experts have shown us that the intravenous method using properly prepared solutions is extremely effective and relatively harmless. They have assured us that intravenous solutions introduced at a proper rate will not overburden even the damaged heart.

But there is still too wide a gap between the basic knowledge supplied us by the scientist in regard to maintaining the balances of the body and the wisdom with which this knowledge is put into practice. The burden of my song is a simple one. Our experts, clinical and scientific, have done their part. Our junior colleagues have the knowledge. It remains for those upon whose shoulders rests the supreme responsibility to see that this knowledge is

utilized. Such not uncommon happenings as the production of edema by the routine daily administration of 1000 to 2000 cubic centimeters of salt solution or the comfortable conviction that a patient is in water balance because we are supplying him 2000 cubic centimeters of water, whether subcutaneously or intravenously, while as a matter of fact, he is losing 1500 to 2000 cubic centimeters by vomiting, 1500 cubic centimeters by sweating, and hopefully, 500 cubic centimeters in the urine, ought not to occur. I plead in short that in this dilemma utterly basic to the patient the surgeon shall clearly demonstrate in his planning that "there is some intellectual process involved."

HUGH CABOT.

MEMOIRS

LORD MOYNIHAN

BERKELEY GEORGE ANDREW MOYNIHAN was born on the island of Malta October 2, 1865, and died at his home in Leeds September 7, 1936. He was the only son of Captain Andrew Moynihan, of Irish stock, who had gained the Victoria Cross in the Crimean War at the assault on the Redan. At the time of his son's birth, Captain Moynihan was of the 90th Regiment. Afterward he was of the 8th Foot (The King's Regiment), and he served with distinction in the suppression of the Indian Mutiny.

The forefathers of Berkeley Moynihan for several generations had held army commissions, but he was not to follow in their footsteps. He was educated at the Royal Naval School and received his medical training at the Leeds Medical School and the University of London. He began the clinical part of his studies at the Leeds General Infirmary in 1886. He took his degree of M.B., B.S. at the University of London in 1887 with the diplomas of the Royal Colleges. He took the F.R.C.S. in 1890, and in the examination for the degree of master of surgery in 1893 was awarded a gold medal. In 1895 he married Isabella Wellesley Jessop, daughter of T. R. Jessop, F.R.C.S., J.P., of Leeds. Moynihan owed much to his early association with Mr. Jessop, who preceded him as surgeon to the Leeds General Infirmary.

Those who are interested in Moynihan's accomplishments, his society memberships, and the various honors which were conferred upon him, I will refer to the English *Who's Who*, which gives these data in detail. My hope, in reviewing the life of Moynihan, is to show him in the picture of his time in England, sketching briefly the achievements which made him outstanding, not only in his profession, but in the intellectual strength of Britain.

It will be remembered that England was slow to accept that great work of Pasteur and Lister which carried scientific medicine farther forward in fifty years than it had advanced in all previous history. When we think of English medicine, we think of London, of the hospitals that had their beginning in the fifteenth century, and of the great men who achieved a place there and made English medicine the leading scientific medicine in the world. One cannot do this without devoting some time to English provincial medicine, and to the accomplishments of physicians and surgeons outside London, some of whom in their later days

Berkeley Moynihan

became part of London. The provinces of England offered in the earlier days, as they offer now, certain advantages to younger men in medicine because conditions of research and practice had not crystallized as they had in London.

Among the provincial towns, Shrewsbury, the home of Darwin (1808–1882), comes to mind. I have visited Shrewsbury and have stood reverently before the statue of Darwin in front of the old grammar school buildings which now house the library and museum. And Manchester was the home of John Dalton (1766–1844), the physicist whose work on the atomic theory associated itself so naturally with medicine. Liverpool was the scene for the work of Sir Robert Jones (1859–1933), loved by all who knew him, father of modern orthopedic surgery. At Newcastle-on-Tyne Rutherford Morison, an able and courageous man, gave great impetus to surgery in many fields. There was James Greig Smith (1834–1897), of Bristol, who wrote a most remarkable work on abdominal surgery, first published in 1887. And so I could go on, naming provincial towns and the great figures in medicine who are associated with them.

Among the many surgeons whose teachings and writings had direct influence in shaping Moynihan's development, a few were outstanding. Perhaps above all there was Lawson Tait (1854–1899), of Birmingham. While English surgeons in general had more or less accepted antisepsis, Tait refused it, but, almost unknown to himself, he adopted its principles, the theory of aseptic surgery. He was a man of strong convictions who, to impress his ideas on the profession, did not hesitate to use invective, and he lived a life of unending controversy. Tait, in a sense, was the father of modern abdominal surgery, not because he originated the many operations which he had the courage to perform, for in fact many of these procedures had been recommended previously, but because he was the first to make them useful.

Leeds for more than a hundred years has been one of the leading medical centers of Great Britain. In its great medical school, families have been represented in which the tradition of surgery has been handed from father to son; for example, in the Teale family through three generations, and in the Hey family through two generations. Joseph Priestley (1733–1804), who isolated oxygen, lived and worked at Leeds before coming to America in 1794.

The two men in Leeds who stood out pre-eminently in their influence on Moynihan's career were Arthur Fergusson McGill (1846–1890), and Arthur W. Mayo-Robson (1852–1933). I give you Moynihan's own words of tribute to them. Of McGill, his first chief at the Leeds General Infirmary, he wrote, "It is impossible to exaggerate my good fortune in falling into such hands for the moulding of my career. McGill was perhaps the greatest genius in surgery I have ever known, and my debt to him is beyond all calculation."

At the time of Mayo-Robson's death, Moynihan said, " . . . I was his house surgeon in 1887–1888. I came to him when he was in his formative stage, and

the lessons he impressed upon a susceptible youth were quite unforgettable. . . . Mayo-Robson must rank among the very greatest surgeons of all time. We who were his colleagues will forever cherish the memory of a surgeon of the very highest rank, who was supreme in technical skill, adventurous in search of truth, restless in eager desire to seek better and still better methods of relieving the sufferings of mankind, of infinite resource, tender, compassionate, merciful."

It was under these illustrious teachers that Moynihan was trained. McGill's early death was a great loss to Leeds and to the profession of Britain and the world. Perhaps the surgical work with which McGill's name is most closely associated is the operative treatment of prostatic hypertrophy. He was the first to establish in England the operation of suprapubic prostatectomy, a procedure which, he generously acknowledged, had been done almost simultaneously but a little earlier by Belfield of Chicago. Mayo-Robson served the University of Leeds and the Leeds General Infirmary from 1882 to 1902, when he went to London, where he continued his work.

When I first visited England, nearly forty years ago, I went to Leeds to see Mayo-Robson because of his contributions to surgery of the upper abdomen—his work on gall-stone disease is still a classic—and it was then that I met Moynihan. I became very much interested in him, and we established a friendship which lasted for life. For more than thirty years I received a cabled greeting from Moynihan on my birthday, sometimes when I myself had forgotten the occasion. The news of his death came as a shock and a grief.

Moynihan began his professional career at a period when leading surgeons viewed one another as rivals. It is to his everlasting credit that largely as the result of his unceasing efforts they came to consider themselves as fellow workers in a cause. Moynihan stood unfailingly for honest medicine. He fought cults and quackeries, and by his debates in the House of Lords relating to medical legislation he accomplished much to keep English medicine clean.

Moynihan was skilled in many fields of surgery, but particularly in that of abdominal surgery. His work on cancer of the stomach and on ulcer of the stomach and duodenum was outstanding. In 1905 he published his monumental book, *Abdominal Operations*, which ran through four editions. This book, although it included only those operations which are common to the two sexes and excluded operations on the kidney and bladder and for hernia, was the most illuminating treatise of its time on abdominal surgery.

Moynihan's work was not easy. Brilliant, indefatigable, a facile writer, an orator of exceptional skill and fascination, he yet had to surmount barriers, as every young man must do if he reaches the heights. At Leeds he upheld the traditions of Hey, Wheelhouse, Pridgin Teale, McGill, and Mayo-Robson, whom he replaced on the staff when Mayo-Robson went to London; but he raised to a higher level still the standing of the school and hospital, and in the years of his

brilliant achievement made Leeds as never before a great medical center. In 1926 he retired from the professorship of clinical surgery of the University of Leeds and became emeritus professor, but as consulting surgeon to the Leeds General Infirmary he exerted his guiding and inspiring influence to the day of his death.

Moynihan was interested in the United States. He was one who contributed greatly to the establishment of the American College of Surgeons. He was a member of the Editorial Board of SURGERY, GYNECOLOGY AND OBSTETRICS where his advice and active participation will be greatly missed. In his many visits to this country, by reason of his scientific presentations in surgery, and at times in the many interesting phases of medicine of the days gone by, he became known and loved by all. He was the supreme speaker in medicine, not only because of his magnetic voice and personality, his polished and beautiful diction, but because of the substance of the ideas he presented. It was not merely knowledge, but knowledge inspired by the wisdom which makes use of knowledge, that made him one of the greatest teachers I have known.

In his later years, because of professional affiliations, Moynihan had occasion to spend much of his time in London. His association with the Royal College of Surgeons of England was very active. He served on the Council and for six consecutive years he was President of the College. He delivered the Arris and Gale Lectures, 1898–1900; was Hunterian professor, 1919–1920; Bradshaw lecturer in 1920; Hunterian orator in 1927. In addition he was Romanes lecturer, Oxford, 1932; Walker lecturer, St. Andrews, 1933; and Linacre lecturer, Cambridge, 1936. In spite of his engrossing occupations in London he maintained his home at his beautiful estate in the outskirts of Leeds.

England is stable, and her stability not only is inherent in the character of her people, among whom fanatics are rare, but it is increased by the custom of the English Government of taking into political and social orders the great men of the country in all walks of life. The men thus elevated are given power to use their abilities for the good of society, not by the votes of the uninformed, not by appeal to the emotions of the people, but because of their genuine worth. The superior position conferred is for life, as are appointments to the bench in England and to the Supreme Court in this country. No matter what the background of the man, if he has added greatly by his intelligence to the economic or social welfare of the people, he may be distinguished, and, if one may say so, may become a stockholder in the English hierarchy. He may become in succession a knight, a baronet, and a baron, as Moynihan so worthily became. As one reviews the life of Moynihan, one sees manifest in its entire course the qualities in the individual which collectively have made England great and stable.

Lord Moynihan, brilliant, versatile, sound, a great surgeon and teacher, will be profoundly missed.

WILLIAM J. MAYO.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE appearance of the authoritative work[1] by Graham and co-workers is an important medical event in view of the great advances that have been made in virtually all phases of thoracic surgery during the 10 years that have passed since the last comprehensive treatise in the English language was presented by Howard Lilienthal.

The authors of *Surgical Diseases of the Chest* have successfully undertaken to present their subject broadly, from the points of view of the internist, the surgeon, the roentgenologist, and the endoscopist. The reviewer is impressed by the authors' freedom from bias and hobbies, without sacrifice of individuality in presenting their subject.

Especially valuable are the chapters on physiology, anesthesia, postoperative pulmonary complications, empyema, bronchiectasis, intrapleural pneumonolysis, oleothorax, and diseases of the esophagus and bronchi endoscopically considered. Chapters dealing with those diseases in which no one clinic has had a broad experience include a vast amount of useful information collected from a large variety of sources. In the opinion of the reviewer, the chapter on artificial pneumothorax and that on the surgical treatment of pulmonary tuberculosis are considerably below the high standard of the work as a whole. Since there are many points about which thoracic surgeons are not as yet in accord, the reviewer will not list even his chief points of disagreement with the authors of the present book.

Surgical Diseases of the Chest is recommended to both internist and surgeon as the most useful work available on chest surgery. JOHN ALEXANDER.

BECK'S *Obstetrical Practice*[2] is a new textbook dedicated to the memory of John Osborn Polak, Beck's predecessor at the Long Island College of Medicine. It is written primarily for students, and for them it presents some advantages not found in other books. Being a first edition, it has some features which seem unfortunate. It is to be hoped that the mention of these will be considered by the author as suggestions for improvement in editions.

The consideration of the ovarian and menstrual cycles is excellent. The chapter on the chronological development of pregnancy is unusually well done, and is a great help to students in that the development of the ovum, the changes in the uterus, the symptoms and findings of pregnancy, are all presented in outline form so that the student has a clear picture of the entire process for each month of development. The chapter on the diagnosis of pregnancy is treated in a similar manner. In the consideration of the mechanism of labor, the illustrated outline summary for the mechanism in various positions of the fetus is a feature which cannot be commended too highly. The author's method of repairing perineal lacerations and episiotomy wounds entirely with catgut is a contribution to the comfort of the patient, as his insistence on the necessity and the possibility of preventing post partum hemorrhages is to her safety.

All illustrations are line drawings. Their great number is sometimes a helpful feature, but in some cases, notably those illustrating the forceps operation, they lack clarity, and occasionally they must be quite unintelligible to students. The consideration of obstetric analgesia and of the treatment of toxemias might well be amplified.

One is disappointed that so little prominence is given to the value of impression of the fetal head in cases of suspected disproportion, and certainly no chapter on resuscitation of the newborn can be called up to date without detailed information as to the value and technique of tracheal catheterization.

J. R. FITZGERALD.

THE new edition of Turner's popular textbook[3] on diseases of the ear, nose and throat has very few changes from the previous except for a slight increase in size and the deletion of some unimportant subjects. A new brief chapter on allergy has been added and nasal polyps are discussed separately. Each chapter has been revised and new illustrations have been added where necessary.

The authors have confined themselves to short, concise statements avoiding lengthy discussions on controversial subjects which tend to confuse the student. No doubt this edition will meet with as much popularity as the previous ones, and will be just as useful to the student or practitioner.

JOHN F. DELPH.

[1] SURGICAL DISEASES OF THE CHEST. By Evarts Ambrose Graham, A.B., M.D., F.A.C.S., Jacob Jesse Singer, M.D., F.A.C.P., and Harry C. Ballon, M.D., C.M., F.A.C.S. Philadelphia: Lea & Febiger, 1935.

[2] OBSTETRICAL PRACTICE. By Alfred C. Beck, M.D. Baltimore: The Williams & Wilkins Co., 1935.

[3] DISEASES OF THE EAR, NOSE AND THROAT; Edited by A. Logan Turner, M.D., LL.D., F.R.C.S.E. Baltimore: William Wood & Co., 1936.